

Lake Lemon Conservancy District



Aquatic Plant Management Plan 2000

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Lake Lemon Aquatic Plant Management Plan

INTRODUCTION TO LAKE LEMON

Lemon is a 1650-acre reservoir located in Unionville, Indiana. Lake Lemon is Indiana's 11th largest lake and was constructed in 1953 for flood control, recreation and as a drinking water source for the City of Bloomington. The lake was utilized for drinking water until the mid-1970s and today serves as a backup water supply source for the City of Bloomington Water Utility (CBU). Historically, Lake Lemon has provided many residents of south central Indiana with a great boating, fishing and swimming resource. See Figure C of the appendix. Recently, Lake Lemon has drawn interest as a training laboratory for Indiana University Limnology students and as a sanctuary for avid bird-watchers in the community. Interest in the lake's ecology and concern for its long-term well being are priorities for its residents and the community as a whole. The lake community is currently addressing several management problems: sedimentation, shoreline erosion and nuisance aquatic macrophytes (plants).

In 1995 a group of residents/freeholders responded to these concerns and formed the Lake Lemon Conservancy District (LLCD and/or The District). The District was formulated in accordance with the Indiana Conservancy Act IC 14-33 to operate, maintain, and manage Lake Lemon for recreation, wildlife habitat and water quality as defined by the CBU to meet backup water supply standards. LLCD has an impressive four-year management history including several shoreline erosion control projects, dam maintenance, and a small main-channel restoration project. The District also participates in the Volunteer Clean Lakes Program, conducts bi-annual water quality testing, and is in the process of developing a watershed management plan. The District's aggressive best management practice philosophy has lead to the recognition and proactive treatment of Lake Lemon's aquatic macrophytes (plants). One of LLCD's goals is to manage the plants with a comprehensive, controlled, and measurable management plan.

This plan is designed to:

1. Identify and document the lake's plant communities and potential aquatic plant problem areas;
2. Explore and determine the most appropriate control strategies for each nuisance plant and/or area;
3. Develop an implementation plan that describes the application and expectations of each control strategy;
4. Design a feasible monitoring and evaluation strategy to track management successes over time; and
5. Make recommendations for future management.

It is the charge of this plan to better understand plant management and to blend plant management goals with the recreational and ecological needs of the Lake Lemon community.

PROBLEM IDENTIFICATION - WHY CONTROL

Aquatic plants, when present in limited populations, can act to improve water quality and enhance habitat and aesthetic character of lakes. However, as these plant populations grow in abundance and distribution, they may upset the balance of desirable fish populations, restrict water flow, and interfere with other lake uses. For several years Lake Lemon has experienced a Eurasian water milfoil (*Myriophyllum spicatum*) infestation (herein referred to as E. milfoil). The plant first appeared in the late 1970s and spread to cover approximately 75% of the lake at its peak abundance. According to a Diagnostic/Feasibility Study conducted in 1986 by the Indiana University School of Public and Environmental Affairs, one of the “major water quality problems in Lake Lemon is the dense growth of Eurasian water-milfoil which was found in nearly all waters of the lake having depths between 0.75 and 3 meters (2.5 and 10 feet). The dense growth restricts boating, swimming and fishing activities.” (Jones, 1986). E. milfoil had been chemically treated by the Bloomington Parks and Recreation Department in the late 1980s and early 1990s; however, treatment was not done consistently and thus, had little effect on retarding its growth. The Parks Department also engaged in some mechanical harvesting of the milfoil. In the summer of 1998 E. milfoil was still found around numerous dock and shoreline areas and growing in dense stands out to six feet in depth.

In addition, dense stands of American Lotus (*Nelumbo lutea*) are encroaching on the east end of Lake Lemon. Boating, fishing, and other recreational uses have been impacted as a result. By the late-1990s, a 450-acre section of the east end had to be buoyed off to warn boaters of shallow, un-navigable waters. Uncontrolled vegetation traps soil carried by flowing water and eventually contributes to severe sedimentation that can shut off water flow as seen recently in the east end of Lake Lemon. The rapid sedimentation rate of Bean Blossom Creek has lead to the filling in of the east end of the lake with sediment. This has created ideal habitat for floating-leafed, emergent plants such as American Lotus. Further, as Lotus increases in density, it functions as a breakwater for the flow from Bean Blossom Creek. This slowing of the water leads to deposits of unusual loads of suspended sediment which contributes to the decreasing depth of the east end. Essentially, as the east end experiences sedimentation and filling-in due to land use in the watershed, Lotus growth increases, and therefore sedimentation increases beyond its expected rate. East end residents are struggling to maintain lake access under current conditions. See figure A.

The District has recently identified two other nuisance plants that may require future management. These plants are Spatterdock or Yellow Cow Lily (*Nuphar lutea*) and Purple Loosestrife (*Lythrum silicaria*). The increase in shallow water has brought about an increase in dense stands of Spatterdock or Yellow Cow Lily in the east end. Such growth is obstructing dock access and inhibiting sport fishing. Additionally, a few Purple Loosestrife plants have been identified around the edge of Little Africa Nature Area (1999). Purple Loosestrife invades and dominates native wetland plant communities causing a negative impact on area wildlife. The District plans to address and control the potential rapid spread of this plant.

PLANT MANAGEMENT UNDER LLCD MANAGEMENT

The District has engaged in intensive management of both *E. milfoil* and American Lotus in the last four years. Management has included chemical herbicide application, mechanical harvesting, and water level drawdown. These strategies have been used in combination with one another in a consistent manner since the summer of 1996. These methods were selected based on the best available scientific knowledge and the budget constraints of the newly formed Conservancy District. The aim of this plan is to identify additional management tools for the District, suggest plant-specific strategies, and to describe a monitoring strategy for evaluating current management and control practices.

In the fall of 1999 Lake Lemon experienced a notable decline in the density and distribution of *E. milfoil*. Such a decline is unusual for an exotic, prolific species such as this one. For this reason, LLCD is interested in monitoring *E. milfoil* and other macrophyte growth over time. Explanations for this decline are speculative; however, it is assumed that current management in regards to *E. milfoil* is proving moderately successful. This decline is pleasing but the decline is not necessarily a trend and therefore, *E. milfoil* should continue to be aggressively managed in the future.



*Figure 1: Aerial Photograph of Lake Lemon during drawdown 1999
Note sedimentation in the east end*

GOALS FOR THE MANAGEMENT PLAN

1. Prevent further water use impairment by aquatic plants;
2. Restore and maintain dock access for residents being locked in by aquatic plants;
3. Increase fishable and swimmable shoreline;
4. Maintain aquatic plant population at levels and/or in areas that are beneficial to water quality protection and to fish and wildlife populations;
5. Maintain aquatic plant diversity through the intensive control of exotics;
6. Promote the use of environmentally sound aquatic plant management practices;
7. Promote the development of comprehensive aquatic plant management methods;
8. Provide an educational and management tool for the District for future years.

THE PLANT COMMUNITY

GROWTH PATTERNS

The primary factors that influence the growth of aquatic macrophytes are water depth, substrate type, water clarity and nutrient availability. These factors vary from one body of water to the next and are influenced by the surrounding watershed. Notable substrate variations are displayed in Figure D of the appendix.

As lakes age they fill with sediment that is rich in nutrients such as nitrogen, phosphorus, and potassium. Waters can become shallower, fertile, and allow plant growth. Runoff from heavy rains carries these nutrients into the water via sediment. Drought may lower water levels, creating shallow areas suitable for increased plant growth. Southern Indiana experiences these climate variations, making management of the aquatic plant community at Lake Lemon a priority.

Human activities also contribute to plant growth. Clearing of land (including agricultural practices) and subsequent soil erosion leads to increased sedimentation and plant growth in lakes. Livestock feedlots and failing septic systems provide additional sources of nutrients. All of these factors have contributed to increased macrophyte growth in Lake Lemon. As mentioned previously, these contributing factors are being addressed in Lake Lemon's forthcoming watershed management plan.

Aquatic macrophytes (plants) display a variety of growth patterns based on individual plant characteristics. These growth patterns are divided into the following categories:

- Emergent – Erect, rooted herbaceous hydrophytes that may be temporarily or permanently flooded at the base. Not tolerant of prolonged inundation of the entire plant. (Bulrushes, cattails, purple loosestrife, etc.)
- Submersed – Vascular or nonvascular hydrophytes either rooted or non-rooted which lie entirely beneath the water surface except for flowering parts of some species. (Milfoils, etc.)
- Floating-leaved – A rooted herbaceous hydrophyte with some leaves floating on the water surface. (Water lilies, Lotus, etc.)

SPECIES TABLE

Table 1: Ecological Significance of Aquatic Plant Species Present in Lake Lemon

Aquatic Plant Species Present	Abundance	Ecological Significance
<i>Ceratophyllum demersum</i> (coontail)	Common	Provides good shelter for young fish and ducklings
<i>Chara vulgaris</i> (muskgrass)	Common	Excellent producer of fish food, especially for young trout, bluegills, sm. and lg. mouth bass; stabilizes bottom sediments; has softening effect on water by removing lime and carbon dioxide. Can become abundant in shallow water and in some cases has become a nuisance to dock owners.
<i>Elodea canadensis</i> (waterweed)	Rare	Provides shelter and support for insects which are valuable fish food
<i>Justicia americana</i> (water willow)	Common	Provides shelter for young fish; serves as a wave break preventing erosion of the shoreline
<i>Lemna minor</i> (lesser duckweed)	Rare	Provides important food for waterfowl and attracts small aquatic animals
<i>Lythrum salicaria</i> (purple loosestrife)	Rare	Exotic and prolific species that provides no positive ecologic contribution to the ecosystem.
<i>Myriophyllum</i> sp. (native milfoil)	Rare	Provides valuable food and shelter for fish; fruits eaten by many waterfowl
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Abundant	Exotic and prolific species that provides little positive ecologic contribution to the ecosystem.
<i>Najas flexilis</i> (bushy pondweed)	Common	Stems, foliage, and seeds important waterfowl food and produces good food and shelter for fish
<i>Nelumbo lutea</i> (American lotus)	Abundant	Provides shade and shelter for fish; young seeds eaten by waterfowl; rootstocks eaten by muskrats and beaver
<i>Nuphar lutea</i> (spatterdock)	Abundant	Leaves, stems, and flowers eaten by deer; roots eaten by beaver; seeds eaten by waterfowl; leaves provide harbor for insects; provide shade and shelter for fish
<i>Potamogeton crispus</i> (curly-leaf pondweed)	Common	Provides food, shelter, and shade for some fish. Exotic plant can form surface mats that may interfere with aquatic recreation
<i>Potamogeton natans</i> (floating-leaf pondweed)	Common	Provides good food for ducks late in the season. Has the potential to become abundant and interfere with aquatic recreation.
<i>Potamogeton nodosus</i> (American pondweed)	Common	Provides good food for ducks late in the season and cover for fish. Can become abundant and develop into a nuisance species
<i>Potamogeton pectinatus</i> (sago pondweed)	Common	The most important pondweed for ducks in addition to providing food and shelter for young fish
<i>Sagittaria</i> sp. (arrowhead)	Rare	Tubers are an excellent food source for waterfowl and muskrats; provides shelter for young fish and young ducks
<i>Scirpus</i> sp. (bulrushes)	Common	Important food source for wildlife
<i>Typha latifolia</i> (cattail)	Common	Supports insects; stalks and roots important food for muskrats and beavers; attracts marsh birds, waterfowl and songbirds; used as spawning grounds by sunfish
<i>Zannichellia palustris</i> (horned pondweed)	Common	Provides cover for young fish

Ecological information obtained from Lake Management Plan for Spring Lake, 1997, *A Manual of Aquatic Plants* by N.C. Fassett, and *Guide to Wisconsin Aquatic Plants*, WI DNR and *A Field Guide to Aquatic Exotic Plants and Animals*, Minnesota Department of Natural Resources.

NUSIANCE SPECIES IDENTIFICATION AND ECOLOGY

American Lotus (*Nelumbo lutea*)

American Lotus is a perennial, aquatic, floating-leaved and/or emergent plant. Lotus is native to the United States. The preferred habitat of this plant is muddy shallow waters such as lake margins. The plant can grow to heights of between one and four feet. Upon reaching the surface of the water, American Lotus may remain as a floating-leaved plant or extend out of the water as an emergent plant. American Lotus can form large mats of dense vegetation that restrict a variety of recreational activities.

Lotus is known to be a sturdy plant that encroaches into shallow waters quickly. American Lotus is recognizable by its large, uncut circular leaves and large pale yellow flowers. Lotus flowers often grow to be 6-8 inches across and are composed of numerous petals. This large flower produces a sturdy seedpod in late summer. (See Figures 2 & 3). While American Lotus does flower and reproduce by seed dispersal, it also propagates by underground horizontal stems called rhizomes (See Figure 4). Knowing the plant's methods of reproduction is important when selecting a control method for Lotus. As discussed later, chemical control is only valuable if it has an effect on all parts of the plant including the rhizomes; therefore, a contact herbicide will be unsuccessful.



Figure 2: American Lotus in bloom



Figure 3: American Lotus Seed Pod



Figure 4: American Lotus leaves, flower, seed pod and root rhizomes

Eurasian Water-Milfoil (*Myriophyllum spicatum*)

Eurasian water milfoil is a perennial, aquatic, submersed plant native to Eurasia and Africa. E. milfoil was accidentally introduced into the United States around the 1940s (Hotchkiss, 1972). Non-native plant species (exotics) such as E. milfoil are often not vulnerable to the same natural population controls, as are native plants. E. milfoil will out compete native plants and dominate the waters of lakes and reservoirs. The preferred habitat of E. milfoil is brackish waters of ponds, lakes, reservoirs and slow streams. The plant usually grows to a height of between 3.0 and 9.0 feet. Upon reaching the surface of the water E. milfoil can form large mats of dense vegetation preventing light from reaching native plants and impeding recreational activities.

E. milfoil is a long, slender plant with green leaves in whorls of three or four with 12-16 pairs of thin leaflets. It is often described as feathery in appearance (See Figures 5 & 6). Recognizing the whorled leaves and the number of leaflets is critical to identifying E. milfoil from other native, less problematic milfoils. While E. milfoil will flower, it most often disperses via fragmentation. If detached, each floating node or fragment can become established if it comes in contact with mud. In addition to its preferred aquatic habitat, E. milfoil has been known to grow terrestrially on soil that is frequently washed with water. Knowing the plant's method of dispersal is vital when selecting a control method for E. milfoil. As discussed later, control methods that require disposal of E. milfoil biomass need to take into consideration the plant's dispersal methods.

Historically, E. milfoil has varied greatly in its density and distribution within Lake Lemon. As mentioned earlier, a drastic decline in the abundance of E. milfoil occurred in 1999. Included in the appendix are maps, which show the location of E. milfoil beds in Lake Lemon in years 1998 and 1999 (See Figures A and B). Mapping was conducted by visual observation in late July of both years. Discussion regarding annual monitoring is in the **Monitoring and Evaluation** Section of this plan.



Figure 5: *E. milfoil* strand.
Note: whorled leaves



Figure 6: *E. milfoil* section.
Note: leaflets number > 12

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife is a herbaceous emergent, perennial, recognized by long spikes of purple flowers (See Figure 7). Purple loosestrife can be found in wet meadows, shores, and in disturbed natural wetland areas (Hotchkiss, 1972). Like *E. milfoil*, purple loosestrife is an exotic species. As such it often out competes native wetland plants and impacts the wildlife that are dependent on the diversity of wetland plants for food. Purple loosestrife first appeared in the United States in the early 1800s but it was not widely spread until inland canals were constructed in the late 1800s (Malecki et al., 1993). Purple loosestrife first appeared in the Lake Lemon proper in the summer of 1999. (Its location is documented in Figure A of the appendix).

Purple loosestrife averages about four feet in height and flowers between June and September. Each flower stalk can produce up to 100,000 seeds. Each year a single mature plant can produce up to 2.5 million seeds that are able to withstand harsh environmental conditions (Nyvall, 1995). Purple loosestrife can spread rapidly in the absence of natural predators or diseases. As LLCD is interested in promoting bird and wildlife habitat around the shores of Lake Lemon it is imperative that this plant be included in future management plans.

Currently, the Little Africa Nature Area supports a diverse assemblage of bulrushes, spike rushes and sedges. The Sassafra Audubon Society (SAS) works in conjunction with LLCD to maintain Little Africa for bird and wildlife habitat. A section of this land was recently planted with both native wetland and upland plants in an effort to increase or improve bird diversity. Additionally, the District and SAS have constructed a bird observation platform in the nature area in pursuit of educational, conservation, and recreational goals. Given these developments and the recent arrival of purple loosestrife in Little Africa, control options should be explored and implemented quickly.



Figure 7: Purple loosestrife in bloom.

Spatterdock / Yellow Cow-lily (*Nuphar lutea*)

Spatterdock is a rooted, floating-leafed plant similar to true water lilies (*Nymphaea species*). Leaves can be submersed, floating, or emergent above the water's surface. The leaves are heart-shaped and slightly longer than they are wide (See Figure 8). Spatterdock reproduces in two ways similar to American Lotus: by seed germination and by underground rhizomes or "runners." The flower is bright yellow with a single row of petals. The preferred habitat of this plant is shallow water but it may intrude into deeper water. Spatterdock, like Lotus, has substantial biomass and quickly impairs boating, swimming and fishing activities.

Spatterdock has been encroaching into the east end of Lake Lemon and is presenting a recreational problem for residents of the Chitwood Addition. (See Figures A and B of the appendix for locations). Spatterdock has not presented a management problem in years past however; Spatterdock's recent spread has raised concern among residents for lake access and the reduced fishing opportunities resulting from its growth. While Spatterdock is a native plant, it still warrants future control in order to accommodate all lake users.



Figure 8: Spatterdock (Nuphar lutea) in bloom

CONTROL METHODS

Table 2: Control Methods for Aquatic, Invasive Plants on Lake Lemon

Control Methods	Advantages	Disadvantages	Cost Considerations
Mechanical Harvesting: Plants are harvested with specialized equipment consisting of a cutting apparatus which cuts up to five feet below the surface of the water and a conveyor system which picks up the cut plants and hauls them to shore.	Removes the plants (nutrients) from the lake; may reduce regrowth or impair reproduction of certain species; plant stalks remaining after harvesting provide cover for fish and other organisms, and stabilize the bottom sediments; selective harvesting may reduce stunted panfish where excessive cover has lead to adverse predator-prey relationships.	Short term method of control; promotes spread of some species via fragmentation (e.g. milfoil); ineffective in shallow water and around docks; eliminates macrophytes thus giving algae a competitive edge; young fish (as many as 5% of juveniles) are frequently caught in harvesters; reduction in plant biomass can reduce diversity of macroinvertebrates.	High capital cost of harvester, maintenance and labor; LLCDO owns harvester and employs two harvesters at \$9.00/hr. An estimated annual cost of operation and maintenance is \$5,800. The cost of a new harvester would be approximately \$95,000.00
Chemical Application: Chemicals are applied to the growing plants in either liquid or granular form. Chemicals often inhibit protein synthesis in plants causing necrosis or death.	Application is easy, fast and convenient; systemic herbicides produce long-term control.	Potential long-term sublethal effects on fish and other aquatic organisms are relatively unknown; non-target nature of chemicals impact native and desirable plants; dissolved oxygen decreases as plants decay; destroys cover and food for fish.	The total cost of a given treatment program has many variables including: quantity of treatment, amount of time devoted to planning and servicing of the treatment contract, etc. The current cost for the Lotus spraying (Rodeo) is \$325.00 per acre and \$272.00 for the E. milfoil spraying (Aquathol K). Sonar treatments are more costly per surface acre, but when longer-term control is achieved, the cost can be less than with a contact herbicide.
Water Level Drawdown: Lowering the water level to a level substantially lower than normal lake conditions. This exposes plant parts to drying and freezing.	Implementation is easy with a flood control/slucice gate; a mild fall may actually bring back desirable emergent vegetation that can help with shoreline erosion; drawdowns are known to help compact flocculent sediments; long term control of nuisance plants if roots are frozen; residents can access plants to rake up root structures.	Several foot drawdown in a shallow lake may put the fish community at risk of low oxygen levels; dependent on spring rains to restore lake level, recreation may be impacted.	Minimal; possible lost recreation revenues in the late fall.
Biological Control: Locating a natural predator of the nuisance plant, introducing it into stands of that plant and allowing it to reduce and maintain the plant's population at an acceptable level.	Known to cause fatal damage to plants thus decreasing populations over time; the predators and larvae are easy to produce; often plant specific (minimal damage to native and desirable plants).	Very recent technology, limited knowledge of adverse effects; harvesting would damage biological control, requires coordination with other control strategies; restricts boating recreation in certain areas.	Costs are relatively high. Approximately \$1.50 per weevil in the case of E. milfoil control; highly labor intensive in placement and monitoring.

*Table synthesized from information presented in *A Lake Management Plan for Eagle Spring Lake*, Southeastern Wisconsin Regional Planning Commission, 1997

PERMITS & REGULATIONS

The Indiana Department of Natural Resources (IDNR) is responsible for the issuance of permits for aquatic macrophyte control. A variety of regulations and exceptions exist regarding control strategies.

MECHANICAL HARVESTING:

Harvesting as a control method is currently **not** regulated by IDNR. Appropriate disposal is recommended however no regulations exist to govern the disposal location(s) of harvested biomass.

CHEMICAL CONTROL:

Regulations for chemical herbicide treatment permits are outlined in 312 IAC 9-10-3, Indiana Administrative Code Sec.3 while the exceptions for chemical treatment permits are outlined in the Indiana Code 14-2-5-10. These codes are available on file at the LLCD office. Research and conversation with IDNR officials (Randy Lang, Indianapolis 1999) indicate the above codes regulating chemical control are the only regulations to which LLCD must comply given LLCD's current plant management practices. LLCD has historically complied with these regulations and its chemical applicator, Aquatic Control, Inc., applies for the necessary aquatic vegetation permits each year.

An application for an aquatic vegetation control permit must include the following information:

- The common name of the plant to be controlled
- The acreage to be treated
- The maximum depth of the water where plants are to be treated.
- The name and amount of the chemical to be used

A regional biologist reviews all applications to insure that total macrophyte eradication is **not** the plant management goal. In fact, IDNR recommends that the minimum macrophyte population be 20-40% of the acreage of the water body.

Individual residents may implement chemical control without securing an aquatic vegetation control permit. This exception allows an individual waterfront property owner to chemically treat ½ acre or 50% of the existing aquatic vegetation in the immediate vicinity of a boat landing, beach or property adjacent to their real estate, whichever is the lesser.

Additionally, chemicals used by the applicator must be approved by the Office of the Indiana State Chemist. Currently, this office approves all three chemicals (Rodeo, Aquathol K, & Sonar) that LLCD applies, or plans to apply. Finally, the surrounding public must be notified of any water use restrictions associated with the chemicals being applied and the date of application.

WATERLEVEL MANIPULATION:

The amount of water removed from Lake Lemon during the winter draw down is not regulated by IDNR. The LLCD Board of Directors and Lake Manager determine the winter level of the lake.

BIOLOGICAL CONTROLS:

Some biological controls are regulated by IDNR. These include the introduction of grass carp and any other non-native species. For instance, using the non-native beetle, *Lythrum Salicaria*, to control purple

loosestrife *would* be regulated by the IDNR Division of Entomology via a permitting process. However, the introduction of a native weevil, *Euhrychiopsis lecontei*, to control E. milfoil does **not** require such a permit (Randy Lang, IDNR, Personal Communication, Indianapolis 1999).

IMPLEMENTATION AND CONTROL

The Conservancy District began maintaining records of aquatic plant management efforts in 1996 and vegetation mapping in 1998. The District does not, however, have records of the herbicide treatment solicited by the Bloomington Parks and Recreation Department for aquatic plant control. The first recorded efforts to comprehensively manage Lake Lemon's aquatic plants are enclosed in this management plan. Aquatic plant management activities at Lake Lemon can be categorized as mechanical harvesting, chemical control, and water level drawdown.

**Table 3: Control Strategies Used at Lake Lemon
For Different Aquatic Plant Species**

Species	Harvesting	Chemical Spraying	Water Level Drawdown	Biological Control
American Lotus	X	X	X	
E. milfoil	X*	X	X	X
Purple Loosestrife		X		X
Spatterdock	X	X	X	

*Not a preferred method. To be utilized when recreational opportunities warrant immediate control.

Table 3 displays appropriate and effective control strategies for each of the plants identified as problematic by LLCDC. LLCDC has implemented some of these controls. LLCDC recognizes that there are other control strategies such as sediment screens, coverings, grass carp introduction, etc. However, these strategies were deemed not feasible for the lake and not desirable for implementation. The size of Lake Lemon, its recreational activities and the ecological implications of these other strategies warrant their omission from this plan. Future consideration will be given to other control strategies as new or improved techniques arise.

MECHANICAL HARVESTING

Under the present control program, Lake Lemon harvests E. milfoil and American Lotus with an Aqua Marine harvester. Harvesting is ongoing from early June through mid September. Typically, plants are selected for harvesting based on whether they are immediately interfering with boat navigation, dock access, or recreation. Recent effort has been placed on harvesting American Lotus before it goes to flower in an effort to retard its seed producing capabilities. Continued harvesting also prevents the plant from storing food in the rhizomes, which supports certain plants through the winter. Plants are **not** harvested throughout the entire lake. See figure E in the appendix for the locations of current harvesting. No state permits are currently required to mechanically harvest aquatic plants in reservoirs. The harvested plant material should, however, be

removed from the water and disposed of at a location well above the high water line to prevent nutrients from washing back into the water. LLCD has selected appropriate disposal sites for harvested plant biomass (See Figure E in the appendix).

CHEMICAL HERBICIDES

As shown in Table 4, the aquatic herbicides Rodeo and Aquathol K have been applied consistently to Lake Lemon since 1996. E. milfoil is typically treated in late June and American Lotus treated in early August. To date, other herbicides such as Sonar and Reward have **not** been utilized to control macrophytes at Lake Lemon. The current applicator, Aquatic Control Inc., suggests that if E. milfoil drastically increases, Sonar in low concentrations could be applied. It is unlikely that Reward will ever be utilized for control due to the turbidity of Lake Lemon. Chemical treatment has been done consistently for the years between 1996 and 1999. See Table 4 for a summary. Figure E of the appendix lists chemical treatment locations. Information about the chemicals Rodeo, Aquathol K and Sonar and their environmental impacts follows.

Table 4: Past Chemical Treatments at Lake Lemon

	1996		1997		1998		1999	
	Acres	Chemical	Acres	Chemical	Acres	Chemical	Acres	Chemical
American Lotus	05	Rodeo	20	Rodeo	20	Rodeo	20	Rodeo
E. milfoil	33	Aquathol K	53	Aquathol K	53	Aquathol K	0	Aquathol K

RODEO

Rodeo is a non-selective aquatic herbicide used to control undesirable emergent vegetation such as American Lotus, Spatterdock, and Purple Loosestrife. Rodeo is a systemic herbicide and kills the entire plant – leaves, stems and roots. Rodeo is absorbed by the plant foliage and moves throughout plant tissues. This interrupts the plant's ability to produce a protein that it needs to live (Monsanto Company, 1992). After treatment, plants wilt, turn yellow, then brown and die. Signs of control occur approximately two to four days after application. Application of Rodeo must occur when plants are actively growing at or beyond the bloom stage. From a management standpoint this means that treatment should occur between July and September (in southern Indiana) when the plants of concern within Lake Lemon (American Lotus, Spatterdock, and Purple Loosestrife) are in bloom. Additionally, the performance of Rodeo may be less effective if the plants are stressed by drought or damaged by mechanical harvesting, disease or insects. Thus, it is important to decide what areas are to be managed by harvesting and which by chemical herbicides. Those selected for chemical treatment should not be harvested. In the past, Lake Lemon has only treated with Rodeo once per growing season. If it becomes desirable to treat more frequently in the future, consideration should be given to the potential for oxygen depletion that may have an adverse effect on the fishery.

Aquatic Ecosystem Effects of Rodeo

Pros –

- 18 years of documented research on glyphosate, the active ingredient in Rodeo
- Research has resulted in a favorable toxicological profile (reference information on file at the LLCDO office)
- It is not known to bioaccumulate in the food chain. Rodeo is highly water-soluble and is rapidly eliminated from the body (Monsanto Company, 1992).
- No water use restrictions – easy management
- Binds to sediment; low potential for leaching into ground water
- Non-volatile – will not damage non-target vegetation via air transport or produce odors that may disturb the surrounding public

Cons –

- Risk to dissolved oxygen levels as plants decay
- Non-selective herbicide – may eliminate desirable plants nearest to treated nuisance plants

AQUATHOL K

Aquathol K is a non-selective aquatic herbicide used to control undesirable submersed vegetation such as Eurasian water milfoil. Aquathol K is a contact herbicide. It kills the plant parts that are exposed to the chemical. Translocation to the entire plant seems to be limited. Aquathol K inhibits protein synthesis where applied (Elf Atochem North America Inc., 1992). After treatment plants will wilt, drop to the bottom and decay. Signs of control occur approximately one to two weeks after application. Application of Aquathol K is most effective when plants are actively growing at or near the surface of the water. From a management standpoint this means that treatment should occur between June and early August depending upon the growth rate of the milfoil. Additionally, performance of Aquathol K may be affected if the water temperature is less than 65°F or if rain or wave action disrupts its contact with the plants. Aquathol K is non-selective so its use will also damage nearby native, desired submersed vegetation such as *Potamogeton* species (pondweeds). Therefore, it is important to decide what areas are to be managed by this herbicide. If possible Aquathol K should be used on areas where E. milfoil is the dominant, even exclusive, submersed species. Damaging native submersed plant communities gives E. milfoil a competitive advantage for future years. Valuable habitat and food is also lost as native plant communities are damaged. In the past, Lake Lemon has only treated with Aquathol K once per growing season. If it becomes desirable to treat more frequently in the future, consideration should be given to the potential for oxygen depletion. As with Rodeo application, Aquathol K results in decaying plant matter that can deplete oxygen levels and may have an adverse effect on the fishery. Using the chemicals as spot or marginal treatment considerably reduces the risk of oxygen depletion.

Aquatic Ecosystem Effects of Aquathol K

Pros –

- Effective for control of an exotic (E. milfoil); allows natives a competitive chance in future years
- Favorable toxicological profile; relatively low toxicity to fish and mammals (reference material on file at LLCD Office)
- Low risk to oxygen level depletion since salts of endothall are slower acting than other herbicides (slower tissue death; less decay at the same time)

Cons –

- Nature of application allows contact with non-nuisance species; pondweed species very susceptible
- Water use restrictions include:
 - No swimming or other body contact for 24 hours
 - No drinking water and cooking for 14 days
 - No irrigation for 14 days
 - No fish consumption for 3 days
 - Complete lake shutdown for 24 hours with numerous sign postings and enforcement of restrictions

SONAR

Sonar is a selective aquatic herbicide used to control undesirable submersed and emergent vegetation such as E. milfoil. Sonar will also effect native plants so consideration should be given to the time of year Sonar is applied to selectively control exotic species. Sonar can be applied in an aqueous solution (Sonar A.S.) or in a slow release pellet (sonar SRP). During the typical treatment season, Sonar takes 30 to 90 days to work as an aquatic plant control. Sonar is a systemic herbicide. Susceptible plants absorb Sonar through their leaves, shoots and roots. Sonar control is slow and therefore the risk of oxygen depletion is very low. Control may last a year or longer. Sonar inhibits a plant's ability to make food. The active ingredient in Sonar is fluridone. Fluridone does not appear to have an adverse impact on water quality or chemistry since it gradually disappears from treated water by photodegradation, plant metabolism, fish metabolism and hydrosoil adsorption (Sepro Corp.). The half-life of fluridone ranges from 5 to 60 days.

After treatment, plants will turn pink or white in color. Signs of control occur approximately 7-10 days after application. Application of Sonar should occur just prior to or during the early stages of active growth. Sonar should be applied when water movement is at a minimum (not during times of heavy rainfall). It is also recommended that a minimum of five acres be treated due to dilution. From a management standpoint this means that treatment should occur between May and June depending on rainfall.

Pros –

- Does not restrict water usage for swimming, fishing, or drinking
- Effective for control of an exotic (*E. milfoil*); allows natives a competitive chance in future years
- Favorable toxicological profile; relatively low toxicity to fish and mammals (reference material on file at LLCDC Office)
- Low risk to oxygen level depletion since fluridone is slower acting than other herbicides (slower tissue death; less decay at the same time)

Cons –

- Nature of application allows contact with non- nuisance species; pondweed species very susceptible

LAKE DRAWDOWN

Another control option utilized by LLCDC is water level drawdown. The dam that formed Lake Lemon includes a sluice gate control. This allows LLCDC to easily manipulate water levels. The time of year the water is drawdown can have a substantial impact on the aquatic plant community. The District had winter drawdowns during the years of 1997-1999, between the months of November and February for a variety of reasons. One reason was *E. milfoil* control. The winter of 1998-1999 was the most substantial drawdown with a reduction of 5 feet. While summer drawdown can often initiate seed germination and growth response within the emergent community, winter drawdown exposes otherwise submersed plants to freezing and drying conditions, causing mortality. While this strategy can prove helpful for reducing the viability of *E. milfoil* around the shoreline, it does have a few limitations. Plants that produce underground tubers are protected from the harsh winter conditions and unless roots, rhizomes and tubers are exposed via raking they can survive and propagate the next year. Additionally, freezing conditions must be sustained in order to have an effect on the exposed plants and plant parts. Depending on the harshness of each particular winter, drawdown may or may not be an effective tool for Lake Lemon.

Additional caution should be taken to ensure that the water volume during the drawdown is appropriate for the fishery. Lake Lemon is a relatively shallow lake (avg. depth ~ 10 ft.) that has large depth to volume ratios in the first six feet (See Table 5). A 4.9-7.5 foot drawdown would remove approximately 65% of the lake volume. This information should be reviewed with caution when deciding on the drawdown level. Decreasing volume too much causes fish to concentrate into a smaller volume of water where oxygen can become limiting, resulting in mortality. If a thick ice and snow cover prevents oxygen mixing at the surface, the risk of a large fish kill increases dramatically. These are important considerations for drawdown management. *E. milfoil* currently does not grow past depths of 4-5 feet. Thus, drawdown should not need to exceed 5 feet below normal pool level.

Table 5: Depth to Volume Information

Depth (m)	Volume (m ³)	Volume (m ³)	Volume (m ³)	Volume (m ³)
0-0.8	0-2.6	3.9	23	23
0.8-1.5	2.6-4.9	3.8	22	45
1.5-2.3	4.9-7.5	3.0	18	63
2.3-3.0	7.5-9.8	2.5	15	78
3.0-3.8	9.8-12.5	1.8	11	89
3.8-4.6	12.5-15.1	1.5	9	98
4.6-7.6	15.1-25.0	0.34	2	100

Total Lake Volume is $1.7 \times 10^7 \text{ m}^3$

Data taken from Diagnostic and Feasibility Study, Jones, 1986.

Given the successes of the previous control methods, LLCD plans to continue the above approach of harvesting, water level manipulation, and chemical application as necessary. Current LLCD management has expressed an interest in moving away from Aquathol K application to treat *E. milfoil* if a successful, ecologically sound biological control could maintain the *E. milfoil* population at reasonable levels.

BIOLOGICAL CONTROL

Often biological control for exotic species such as *E. milfoil* requires the introduction of another exotic into the aquatic community. However, recent research has lead to an exciting discovery of a **native** biological control for *E. milfoil* known as the milfoil weevil, *Euhrychiopsis lecontei*. The milfoil weevil has been collected from lakes in the Eastern and Midwestern United States and is now being cultivated in laboratory settings. The weevil is small (~2-3 mm.) in size and reproduces by laying eggs on the growing tips of milfoil (See Figure 9). As the eggs hatch, the larvae begin to feed upon the plant. The larvae form pupae in the lower stem of the plant, adults hatch out, swim to the top of the plants and begin the life cycle again. In the Midwest, the weevil goes through about three generations in a summer (EnviroScience, Inc.). Over the winter, weevils move into the leaf litter around the lake margins and return to the water and milfoil the following spring.

Weevils feed on both the milfoil leaves and the conductive tissue inside the stem. Laboratory experiments have shown the milfoil weevil to prefer *E. milfoil* to native milfoils; although, some native milfoil mortality is expected. Other aquatic plants such as coontail, elodea, and naiad have been unaffected by weevil introduction. Additionally, weevils do not bite or sting thus, do not present a recreation hazard.

There are several concerns to keep in mind when considering weevils as a feasible management tool. First, biological controls such as the weevil may take several years to display dramatic effects. Second, weevil introduction would require restricted boat access at the introduction sites. This restriction would be temporary until the weevils are established. Milfoil weevils can endure wave energy but cannot endure boat propellers. Finally, weevils as a control strategy can be implemented along with other control strategies such as harvesting

or chemical spraying but separate parts of the lake would have to be managed differently. Weevil populations will remain in the lake as long as a small milfoil population remains.

Native weevil introduction is a control method that LLCD would like to consider for future years. At the time of this plan, this is the only biological control under consideration. LLCD is opposed to grass carp introduction due to the potential damage to native plants.



Figure 9: Milfoil weevil, *Euhrychiopsis lecontei*

MONITORING AND EVALUATION OPTIONS

- Mapping – Field surveys conducted by LLCD staff and a chemical contractor estimate the abundance and distribution of aquatic plant species in Lake Lemon, provide the best quantitative data available at a low cost. Large Mylar overlays are placed over a topographic map in the LLCD office each growing season. The overlay shows the extent and composition of problematic aquatic plants and all control strategies utilized that year. This mapping effort depicts the locations of harvested plants and chemically treated plants including the relevant dates of control. These annual overlays allow for comparison of plant distribution from year to year.
- Biomass Accounting – An LLCD plant biomass data sheet has been constructed (See Figure F of the appendix). The harvester operator utilizes this data sheet to track the amount of plant biomass removed each year. This is another low cost, quantitative method for LLCD management that provides a year-to-year comparison. This monitoring strategy allows LLCD to evaluate abundance in addition to distribution. This simple strategy compliments the above mapping technique and provides LLCD with a feasible annual monitoring program.
- Chemical Application Annual Review – Keeping accurate records of the acreage sprayed by chemical controls provides an estimate for the extent and abundance of nuisance plants each year.

Reduced acreage can offer insight into effective management of years past and highlight seasonal or biological changes within certain plant species.

- Aerial Photos – One way to qualitatively track plant distribution and relative abundance is to take low flying aerial photographs of the lake at peak plant growth in early August of each year. Visual comparison from year to year would identify the effectiveness for the past years' control strategies. While this method would provide interesting historical documentation of the plant communities and other physical changes around the lake, this is not a feasible monitoring technique for Lake Lemon at this time. Annual aerial photographs cost approximately \$350.00 per fly over and due to the District's budget constraints this is not a recommended monitoring strategy for Lake Lemon.

RECOMMENDATIONS AND PLANNING

HARVESTING STRATEGIES

- Select areas for harvesting based on goals such as preventing further water impairment, restoring dock access, etc. Methods of aquatic plant control are **not** designed to eradicate the plant community but to maintain a healthy balance. Proceed cautiously when harvesting American Lotus in the east end of the lake. See Figure C of the appendix for spawning and nesting sites of fish associated with the east end vegetation. Align harvesting strategies with LLCD's upcoming fishery improvements. Currently, harvesting practices (See Figure E of the appendix) are not interfering with the ecological benefits that aquatic plants provide.
- Utilize the harvester for E. milfoil control only when absolutely necessary due to its ability to reproduce by fragmentation.
- Cut Lotus in early spring when the leaves appear on the surface. Early spring is also the most opportune time for operating the harvester as the water level supports a depth favorable to float the harvester in the shallow areas of the east end. The continued harvesting in select locations will prevent the Lotus from blooming, which will reduce seed production and prevent the plant from storing food in the rhizome which supports the plant through the winter.

CHEMICAL SPRAYING & BIOLOGICAL CONTROL

- Continue intensive chemical control of the American Lotus via Rodeo.
- Upon a heavy return of E. milfoil consider a low dose application of Sonar if spring weather conditions permit. Sonar has longer lasting effects than Aquathol K as it is a systemic herbicide and carries no water use restrictions.

- Chemically treat purple loosestrife with Rodeo as soon as permits allow. Application should be done cautiously so as not to spray nearby native plants.
- In areas that LLCDC does not see as necessary for chemical treatment, but where the resident(s) still perceive macrophytes to be an aesthetic or recreational problem, direct the resident(s) to regulations governing chemical treatment without a permit (Indiana Code 14-2-5-10).
- Explore biological controls for E. milfoil and look toward implementation of the milfoil weevil in the next three years. Costs are equivalent to chemical treatment but there are fewer environmental risks. Weevils are natural inhabitants of Indiana lakes and Lake Lemon is a great laboratory for exploring the southern extent of these organisms. At this time, the weevil requires no permitting and no water use restrictions.
- Do not introduce grass carp (*Ctenopharyngodon idella*) into Lake Lemon. Native plants are vital to the ecology of the lake and given their current abundance and distribution, they would not withstand the pressures of grass carp forage. Additionally, rough fish such as this increase turbidity, and therefore decrease water quality.

OTHER EFFORTS

- Continue active monitoring and mapping of vegetation. Good plant management is dynamic. Control strategies should be decided based upon past successes or failures. Plant management is an active process that needs annual review and discussion. Compare distribution and abundance from year to year before proceeding with management options.
- Increase public education about aquatic plant reproduction and control and encourage resident involvement. Given the mild winter climate of southern Indiana, winter drawdown has limited opportunities to cause plant mortality due to freezing. Problematic shoreline areas need raking during winter months to expose root systems to the harsh conditions.
- Utilize the LLCDC newsletter to inform lake residents of aquatic plant reproductive strategies and the benefits of maintaining a reasonable population of native macrophytes.
- Solicit help from the academic community to identify native plant communities including an inventory of the emergent plant diversity. Knowledge of the emergent community would supply live plants or seeds for transplant to eroding areas.
- Include plant restoration and increased plant biodiversity into the future east end remediation plan. Nurturing the plant community, especially the emergent community, by increasing diversity will guard against the invasion of non-native wetland plants like purple loosestrife.
- Address the sedimentation problem in the east end. Seek funds to remedy land use practices upstream as those practices bring in nutrients and sediment that foster macrophyte growth.
- Consider a late summer drawdown to bring back emergent vegetation that would stabilize shorelines and provide better fish and wildlife habitat. Many seeds of emergent plants such as Arrowhead need low water levels during warm temperatures in order to germinate.

SUMMARY

The ultimate goal of an aquatic plant management plan is to balance the recreational desires of the community with the ecological well being of the lake. Achieving an ecological and recreational balance is a difficult task. It requires an accurate assessment of the current ecological needs and recreational desires, a well-researched management strategy, and an effective method of tracking the progress of the proposed management strategy. To help determine the ecological needs and recreational desires the range of the aquatic plants in and around Lake Lemon is recorded and then compared to the lake usage of various recreational activities. The management strategy is determined by comparing several different control methods and choosing the most appropriate control strategy for each species plant. The management strategy also identifies non-chemical alternatives for managing nuisance aquatic plants. In order to track the progress of the proposed management strategy the plan describes a monitoring program that will allow changes in range of the aquatic plants and the areas of various control techniques to be quantified and recorded. This will allow the effectiveness of the chosen control and management strategies to be tracked over time.

This plan attempts to lay the groundwork for balancing the ecological needs of Lake Lemon with the recreational desires of the lake community. It not a final copy, but a work in progress. Effective aquatic plant management is a dynamic process. A management strategy must be able to adjust to changes in species type and distribution, recreational activities and desires, and advances in technology.

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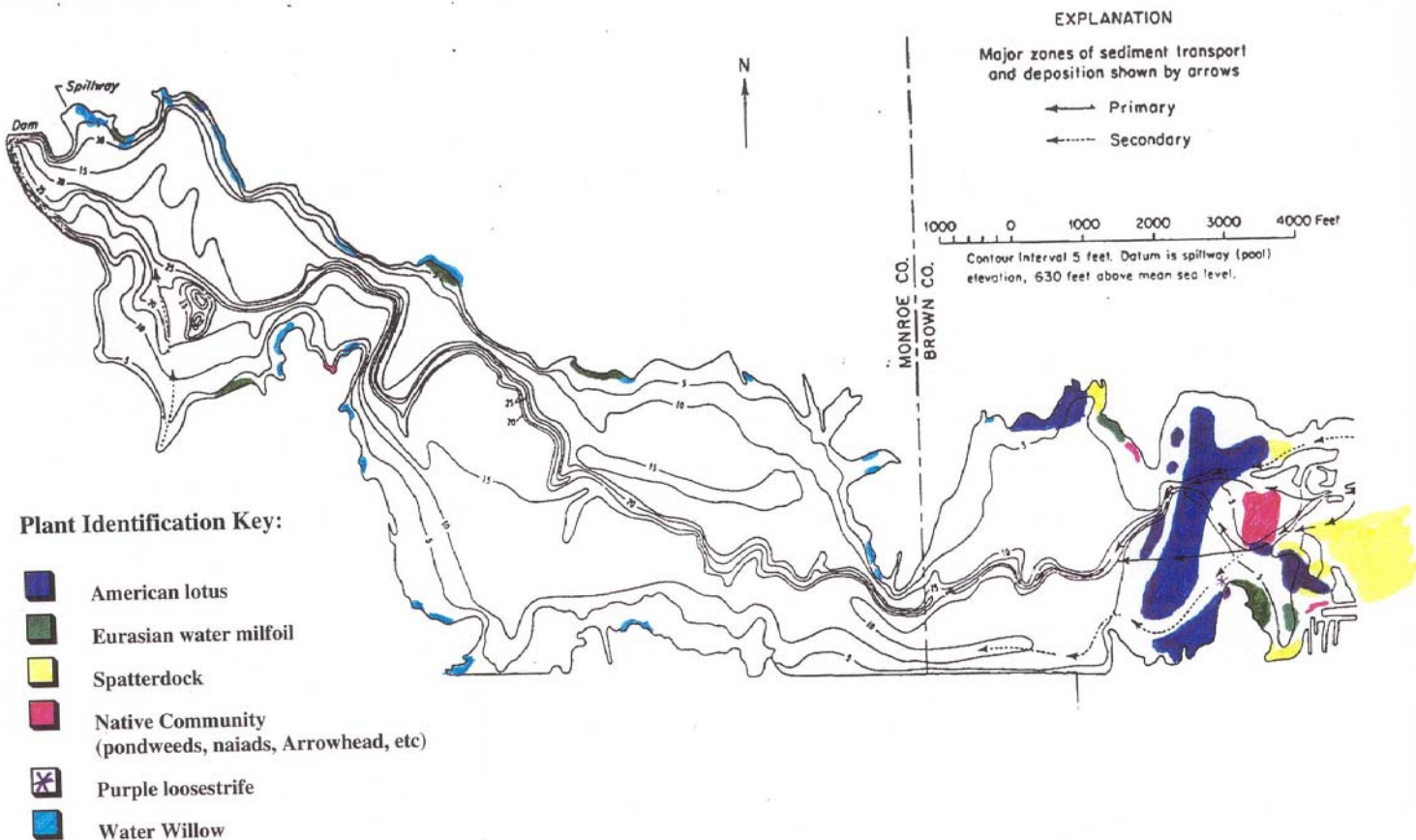


Figure A: Composition and distribution of Lake Lemon's aquatic vegetation in 1999

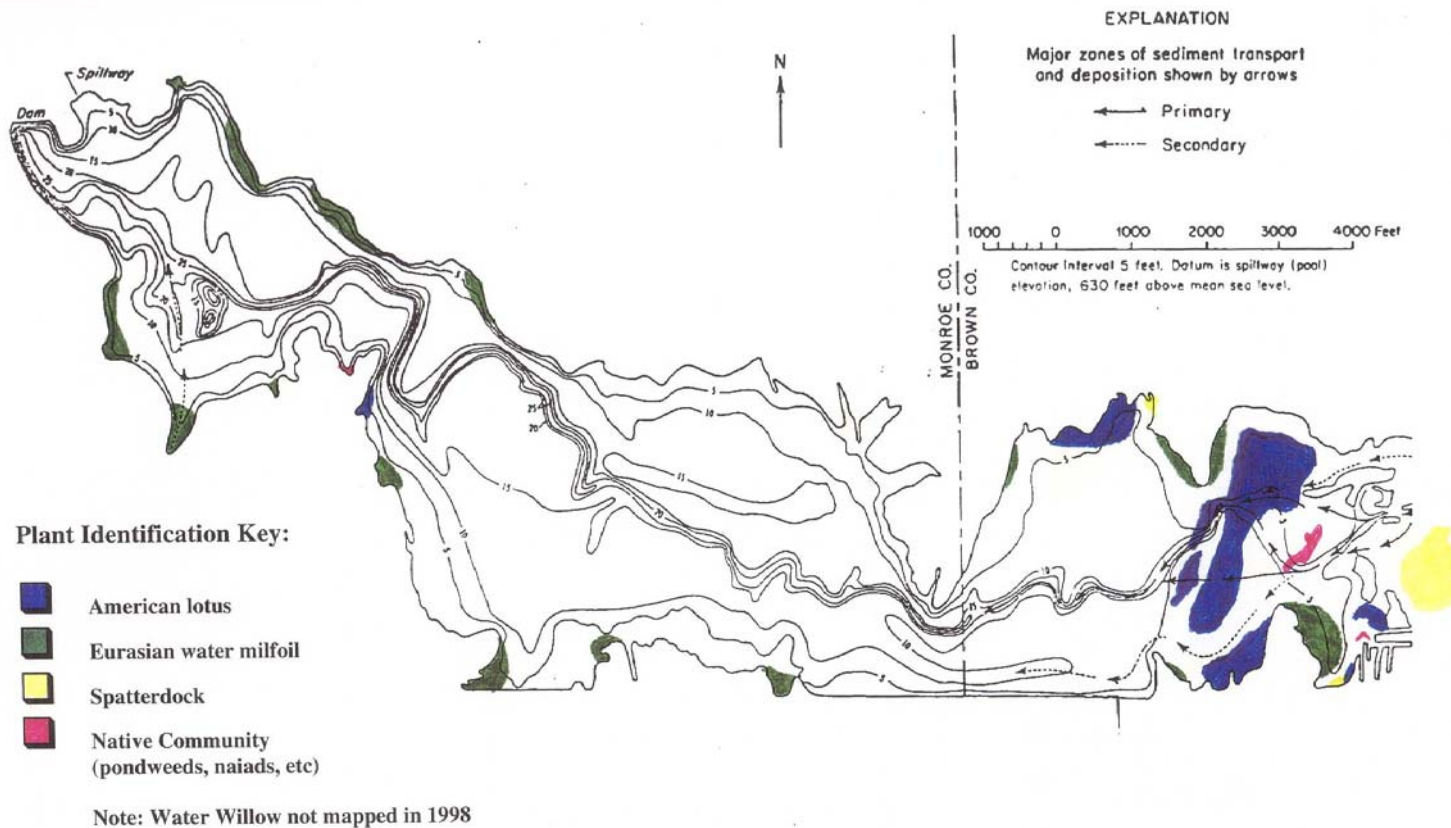
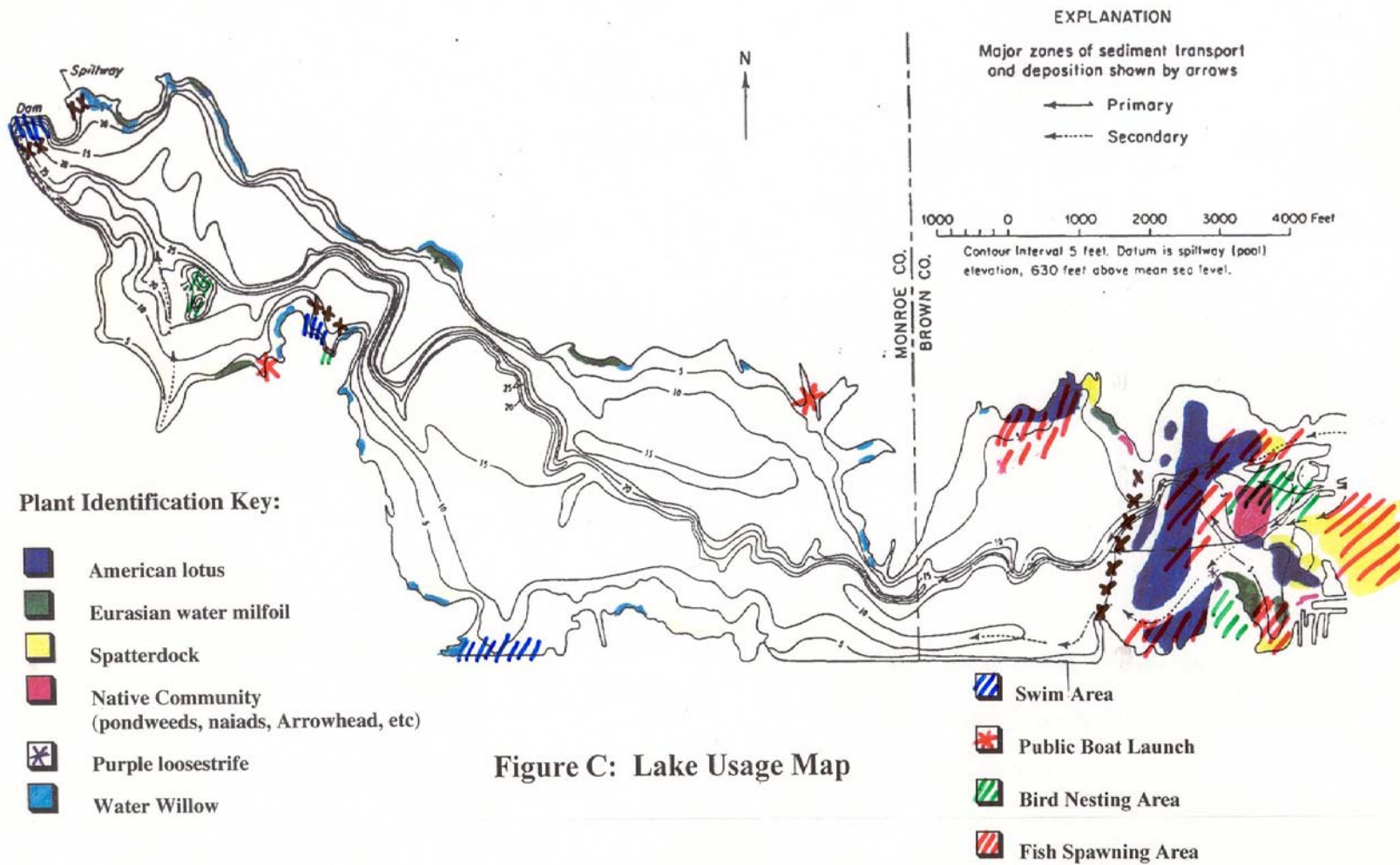
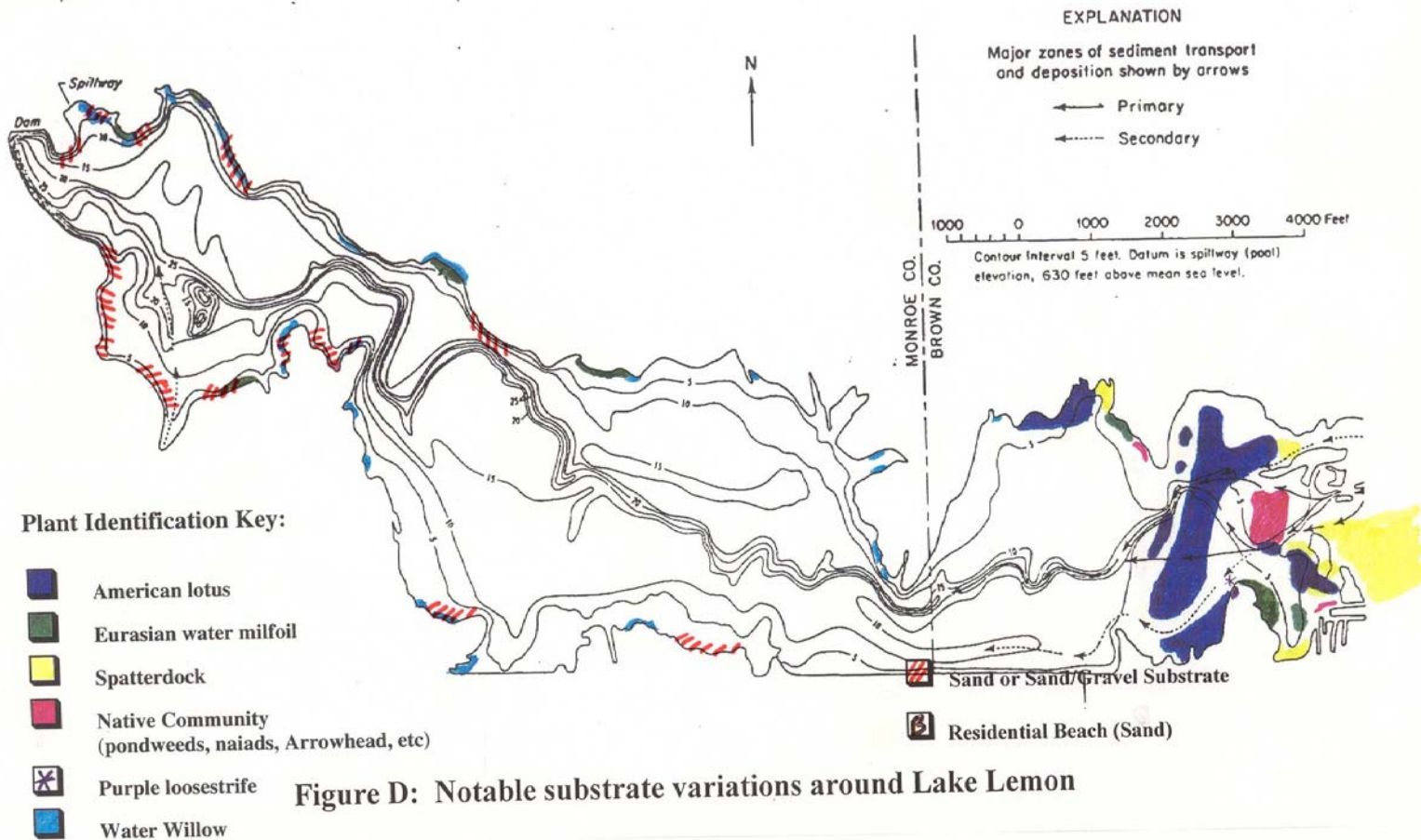
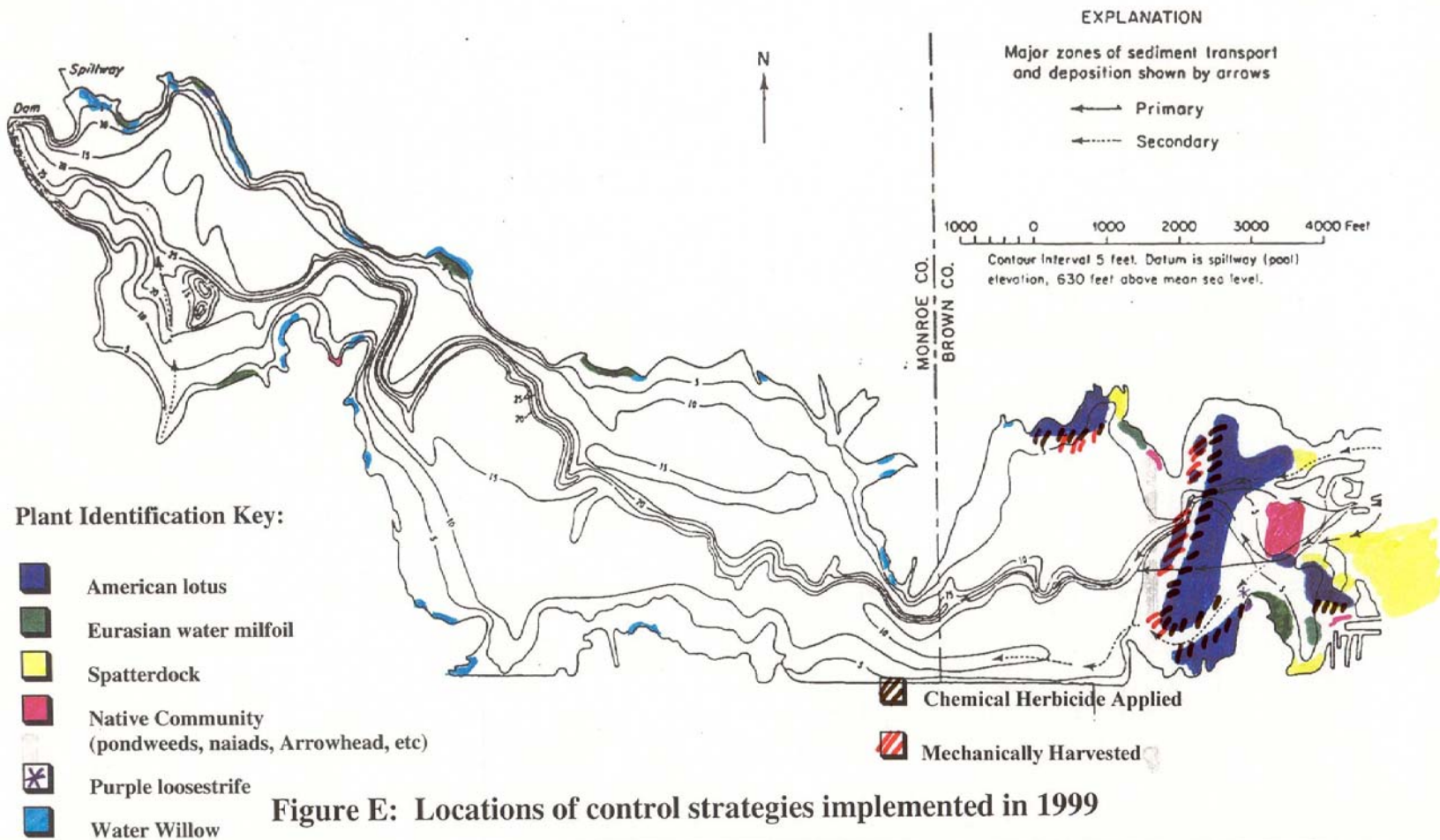


Figure B: Composition and distribution of Lake Lemon's aquatic vegetation in 1998









Lake Lemon Conservancy District

June 22, 2001

Brian Schoenung
District Fisheries Biologist
PO Box 16
Avoca, IN 47420

Dear Brian:

Enclosed, please find a description of the aquatic plant communities present on Lake Lemon and management practices implemented during the summer of 2000. A map of the vegetative communities and the locations of chemical treatment are also included in this package. Please add this information to your files as an addendum to the Lake Lemon Conservancy District Aquatic Plant Management Plan.

If you have any questions, please feel free to contact me.

Best wishes,



Ethel Wilkerson
Lake Biologist

Appendix 1- 2000 Vegetation Growth and Treatment Information

I. Nuisance/Exotic Managed Species

American Lotus (*Nelumbo lutea*)

The cool, rainy spring and early summer resulted in a late but substantial crop of American Lotus. Similar to previous years, the growth was primarily concentrated in the eastern end of the lake. However, small patches of plants were observed in many areas including areas directly east of Point Idalawn and in a cove east of Riddle Point Park (See Figure A for growth distribution).

Twenty acres of lotus were chemically treated using Rodeo on August 3rd. Areas of lotus that did not respond to the treatment were retreated on August 30th and September 20th (See Figure A for areas sprayed). Conservancy District staff did not mechanically harvest any areas to control the presence of American Lotus.

Eurasian Water-Milfoil (*Myriophyllum spicatum*)

Milfoil made a strong resurgence late in the season after a year of sparse growth in 1999. Milfoil growth remained patchy until mid-July, then dramatically increased in August, and growth remained strong until the end of September. See Figure A for Milfoil distribution.

A total of 32 acres of Milfoil were chemically treated using Aquathol-K. Fifteen (15) acres were treated on July 31st and seventeen (17) acres were treated on August 30th. Six (6) acres (three (3) on August 30th and three (3) on September 20th) were retreated due to incomplete chemical control. See Figure B for a map of the treated areas and an end of season evaluation on effectiveness. The Conservancy District staff did not mechanically harvest any areas to control the presence of Milfoil.

Purple Loosestrife (*Lythrum salicaria*)

Several (10-15) plants of Purple Loosestrife were observed growing on a rocky point on the south shore of Lake Lemon on July 19th (See Figure A for mapped location). The plants were removed by cutting the seed heads and stems, taking care to avoid dispersing or transporting the seeds. The roots could not be effectively dug out due to the rocky terrain.

The property owners were notified that Purple Loosestrife had been removed from their property; were given educational literature about the plant; and were requested to monitor the area for additional plants. Conservancy district staff closely monitored the property and the surrounding areas for the remainder of the summer. The close observation of the area will continue in the spring and summer of 2001.

The site on which the plant was observed in 1999 did not exhibit any growth in 2000, nor did any other observable location on the lake.

II. Native and Non-Managed Species

Spatterdock (*Nuphar lutea*)

The distribution of Spatterdock continued to expand during the 2000 growing season. Spatterdock growth is concentrated along the banks of Beanblossom Creek, the stream channels on the north east side of the Conservancy District, the channels of Chitwood Addition, and the bay east of Chitwood (See Figure A). Residents have voiced complaint over lost access and reduced fishing opportunities in these areas. Spatterdock is a native plant and is ecologically beneficial, but its increasing distribution may warrant investigation of possible methods of control.

American Pondweed (*Potamogeton nodosus*)

An increase in Pondweed was observed during the summer of 2000. The plants existed in small, sparse patches primarily in the eastern end of the lake.

American pondweed is a submersed plant with elliptical shaped floating leaves and lance shaped submerged leaves. The leaves are between 5 to 20 centimeters long with the submerged leaves noticeably smaller than the floating leaves. American pondweed produce green flowers on one to three inch emerged spikes. American pondweed flourishes in soft sediment or substrate and can grow in water up to fifteen feet deep.

All species of pondweeds (*Potamoeton* spp.) are considered ecologically beneficial plants because the fruits and tubers provide food for wildlife and the submerged leaves provide good cover for fish. The presence of Pondweed will continue to be monitored and if growth patterns become more abundant, it will be included in future vegetation mapping. In some lakes, excessive growth of pondweed has interfered with the use of docks and boating lanes. This is not a current issue of concern for Lake Lemon but prompts the management to monitor and record the growth of this species.



Pondweed (Photo from University of Florida,
Center for Aquatic and Invasive Plants)

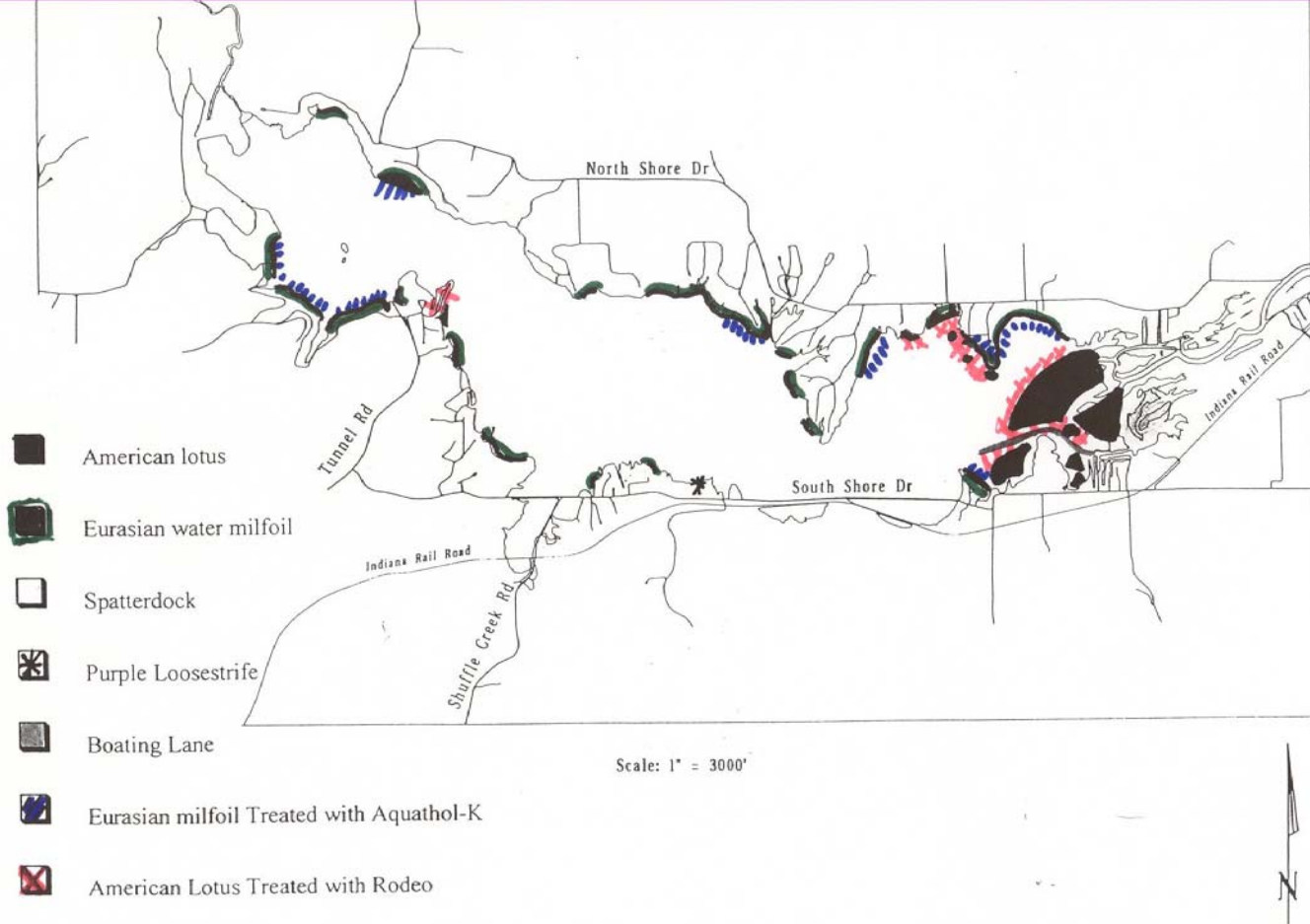
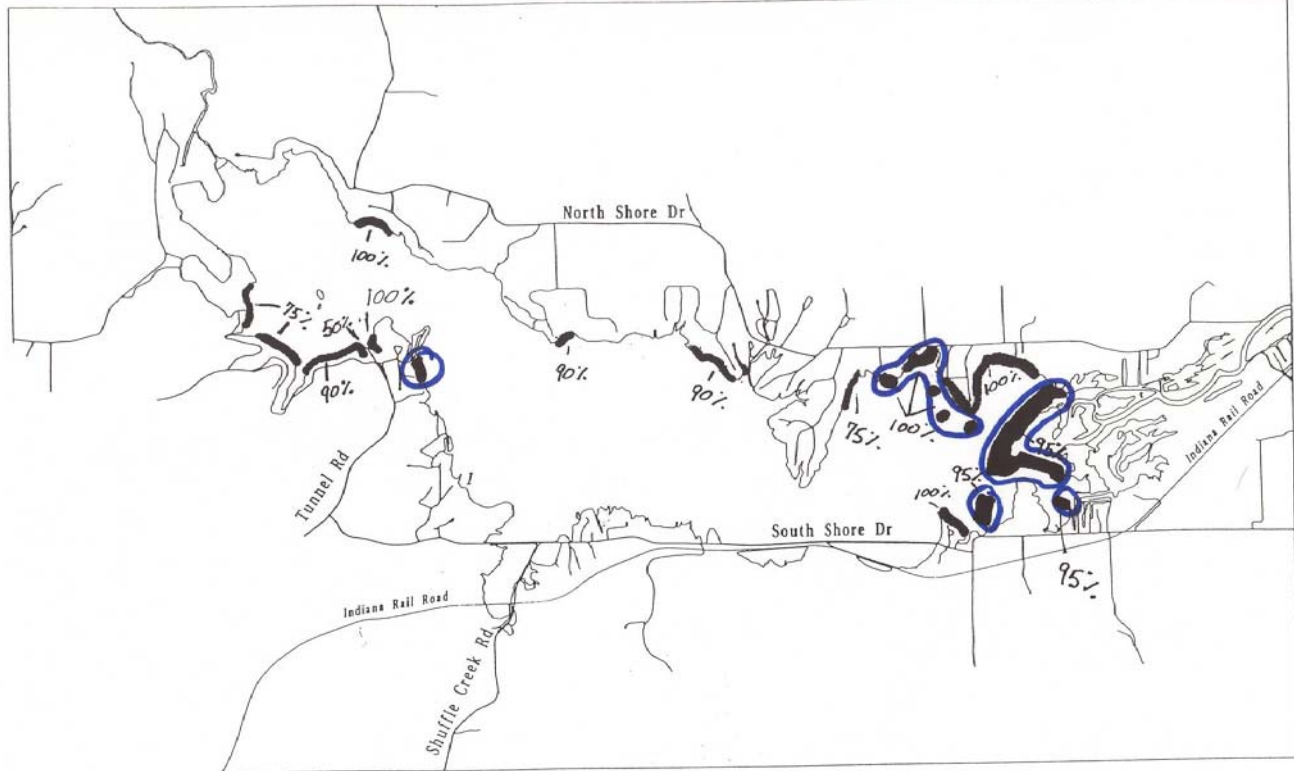


Figure A: Vegetation Distribution and Treatment in 2000



Scale: 1" = 3000'



Eurasian Milfoil Treated Using Aquathol-K

American Lotus Treated Using Rodeo

Figure B: Effectiveness of Chemical Treatment

21 Mar 2001

LAKE LEMON 2001
VEGETATION CONTROL PROGRAM
SUMMARY

May 10, 2001

- Inspection of lake for Eurasian Water Milfoil (EWM) and American Lotus by Bob Madden, Lake Manager; Bill Cobb, District VI Director; Ethel Wilkerson, Lake Biologist; and Scott Shuler, Aquatic Control Biologist
- EWM was growing into water column
- EWM growing earlier than normal
- Above average Secchi disk depths (5 feet, per Ethel)
- Low growth on Lotus

May 17, 2001

- Treated 34 acres of EWM

June 25, 2001

- Treated 34 acres of EWM
- Retreated 4 acres of EWM

July 30, 2001

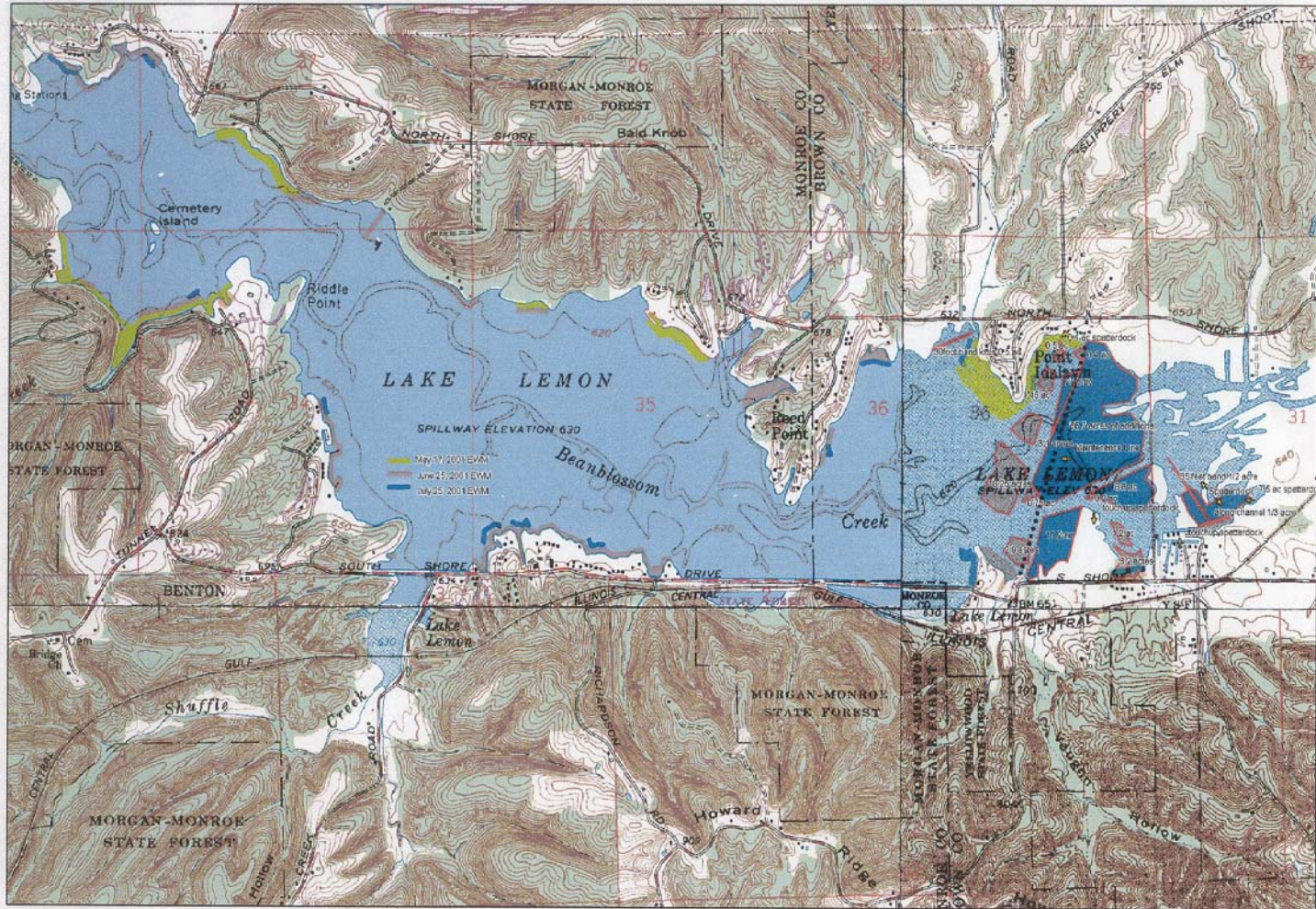
- Treated 4 acres of EWM
- Retreated 3 acres of EWM
- Inspection Lotus for treatment by Bob Madden, Ethel Wilkerson, and Scott Shuler
Used GPS to map areas designated for treatment (see topographic map)

August 2, 2001

- Treated 20 acres of American Lotus and 0.5 acres of Spatterdock

October 9, 2001

- Retreated 4 acres of American Lotus



LAKE LEMON
2001 AQUATIC VEGETATION CONTROL
EXPENSE SUMMARY

CHEMICALS

Date	Unit (gallons)	Chemical	Price per Gallon	Total
12/29/00	100	Aquathol K	\$57.72	\$5,772.00
5/17/01	70	Aquathol K	\$58.16	\$4,071.20
6/25/01	170	Aquathol K	\$58.16	\$9,887.20
7/30/01	20	Aquathol K	\$58.16	\$1,163.20
8/2/01	12.5	Eagre	\$87.90	\$1,098.75
8/2/01	8	Polyan Spray	\$22.06	\$176.48

TOTAL CHEMICALS: \$22,168.83

APPLICATION FEES

Date	Acres	Species	Price per Acre	Total
5/17/01	34	Milfoil	\$50.00	\$1,700.00
6/25/01	34	Milfoil	\$50.00	\$1,700.00
7/30/01	4	Milfoil	\$80.00	\$320.00
8/2/01	20.5	Lotus	\$265.00	\$5,432.50

TOTAL APPLICATION FEES: \$9,152.50

TOTAL 2001 VEGETATION CONTROL EXPENSES: \$31,321.33

Appendix 1- 2001 Vegetation Growth and Treatment Information

I. Nuisance/Exotic Managed Species

American Lotus (*Nelumbo lutea*)

The east end of Lake Lemon supports a substantial crop of American Lotus (See Figure A). The six years of chemical treatment has been successful in reducing the size of its distribution in the east end of the lake and preventing further encroachment. The current goal for chemical treatment of Lotus is the maintenance line shown in Figure A. Lotus growing west of this line will be removed using chemicals while vegetation growing east of the line will not be treated. Continued maintenance of the area west of the maintenance line is expected due to the existing seed bank in these areas.

Twenty acres of lotus were chemically treated using Eagre (a chemical similar to Rodeo) on August 2nd. (See Figure A for areas sprayed). Four acres of lotus were resprayed on October 9th to end the vegetation treatment season. A small patch of Lotus east of Riddle Point Park was not treated because it provides cover for fish but it will be monitored to prevent its spread to other areas of the lake.

Conservancy District staff did not **mechanically harvest** any areas to control the presence of American Lotus.

Spatterdock (*Nuphar lutea*)

The distribution of Spatterdock continued to expand during the 2001 growing season. Spatterdock growth is concentrated along the banks of Beanblossom Creek, the stream channels on the north east side of the Conservancy District, the channels of Chitwood Addition, and the bay northeast of Chitwood (See Figure A). For the past several years, residents have voiced complaint over lost access and reduced fishing opportunities in these areas. LLCD received a permit from IDNR to treat 0.5 acres of Spatterdock in 2001. An area of Spatterdock blocking access to docks on the north east side of the lake and a narrow boating channel through a bay in Chitwood Addition was treated using Eagre on August 2nd (See Figure

A). Spatterdock in the channel was treated to reclaim a boating channel used by residents and anglers leading from the bay to Beanblossom Creek. The LLCD Board of Directors is currently working on a long-range plan for management of Spatterdock in the eastern end of the lake. Combining the goals of anglers and residents LLCD hopes to reopen access areas and prevent further spread of the plant while maintaining some areas for fish and wildlife habitat. Steve Love, District VII Director, submitted an east-end Spatterdock plan to remove approximately fifteen acres over the next five years (see attached plan). In order to implement this plan, LLCD will seek a permit from IDNR to chemically treat larger areas of Spatterdock.

Eurasian Water Milfoil (*Myriophyllum spicatum*)

The dry and hot early spring resulted in a dense Milfoil growth in early May. The lack of rain reduced the amount of sediment entering the lake from Beanblossom Creek. The water column was uncharacteristically clear. Secchi disk measurements exceeded 5 feet. Milfoil flourished even in deeper areas of the lake that usually do not report excessive growth (Figure B). Due to the excessive milfoil growth observed in Lake Lemon, LLCD requested a permit to chemically treat additional acres of milfoil. As the summer progressed, the transparency decreased and the growth of milfoil slowed (Figure C).

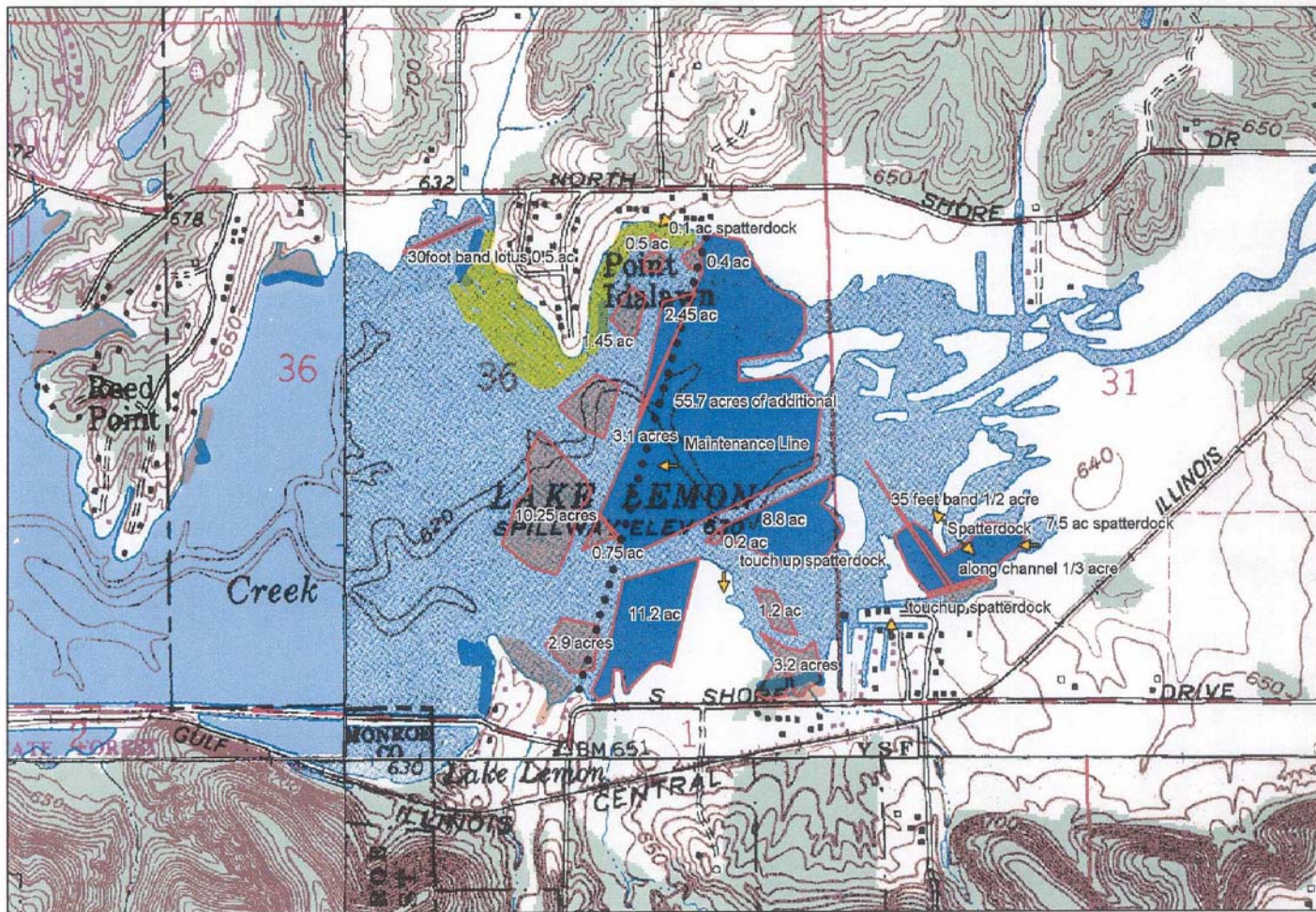
A total of 72 acres of Milfoil were treated in 2001 using Aquathol-K. Thirty-four (34) acres of Milfoil were treated on May 17th; thirty-four (34) acres were treated on June 25th; and 4 acres were treated on July 30th. The Conservancy District staff did not **mechanically harvest** any areas to control the presence of Milfoil.

Purple Loosestrife (*Lythrum salicaria*)

An ornamental planting of six plants of Purple Loosestrife was discovered in the yard of a lakeside residence in early July (Figure D). The plants were planted by a landscaping company, who claim the plants were sterile hybrids and not able to produce seeds. The purple loosestrife was planted before the ban on the sale and planting of purple loosestrife plants, including hybrids. The property owners were informed about the problems associated with Purple Loosestrife and agreed to remove the plants from their yard.

Approximately 60 plants of Purple Loosestrife were observed in three areas on Lake Lemon on July 12th (See Figure D for mapped location). Two plants were observed on Little Africa, the location of the first recorded Purple loosestrife plants on Lake Lemon in 1999 (mapped location D) and 15 to 20 plants were observed in the same area from which plants were removed in 2000 (mapped location C). An area without previous documentation of Purple loosestrife had dense growth of approximately 40 small, young plants (mapped location B). All plants were removed first cutting the flowers and seed heads taking care to avoid dispersing or transporting the seeds. In the areas with less dense growth the entire plant including the roots were removed. The one area with the densest growth of plants was sprayed with Round-Up taking care to avoid contamination of the nearby lake water.

The property owners were notified that Purple Loosestrife had been removed from their property; were given educational literature about the plant; and were requested to monitor the area for additional plants. Educational literature was also distributed at a monthly Board of Directors meeting. Conservancy district staff closely monitored the surrounding areas for the remainder of the summer. The close observation of these areas will continue in the spring and summer of 2002.



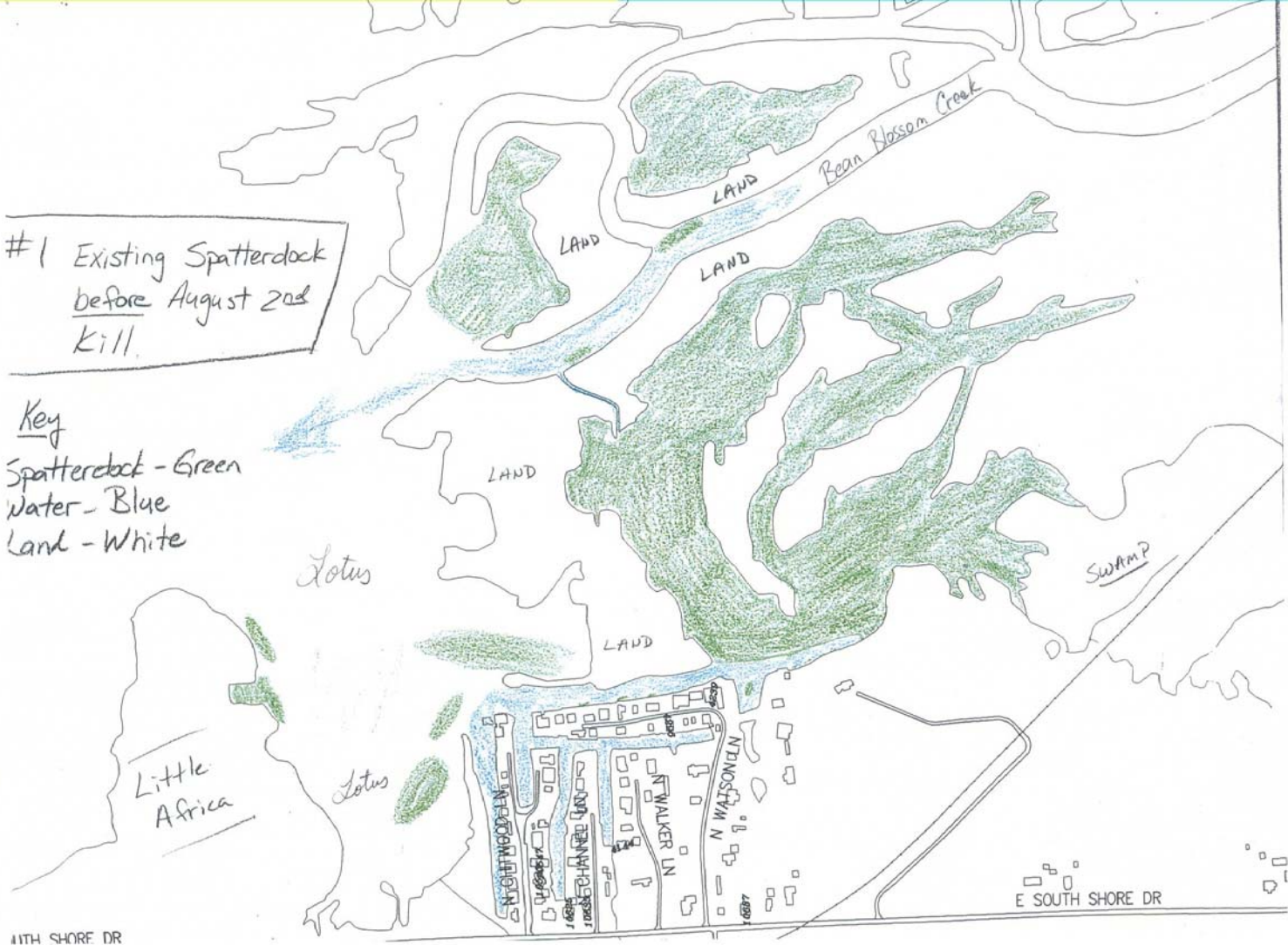
© 2000 DeLorme. DeLorme XMap Geographic; Data source provided by USGS.

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Figure A: American Lotus and Spatterdock

#1 Existing Spatterdock
before August 2008
Kill.

Key
Spatterdock - Green
Water - Blue
Land - White



#2 Existing Spatterdock
after August 2nd
kill

Key
Spatterdock - Green
Water - Blue
Land - White

Lotus

Little
Africa

WILSON DR



#3 Spatterdock Eradication Plan

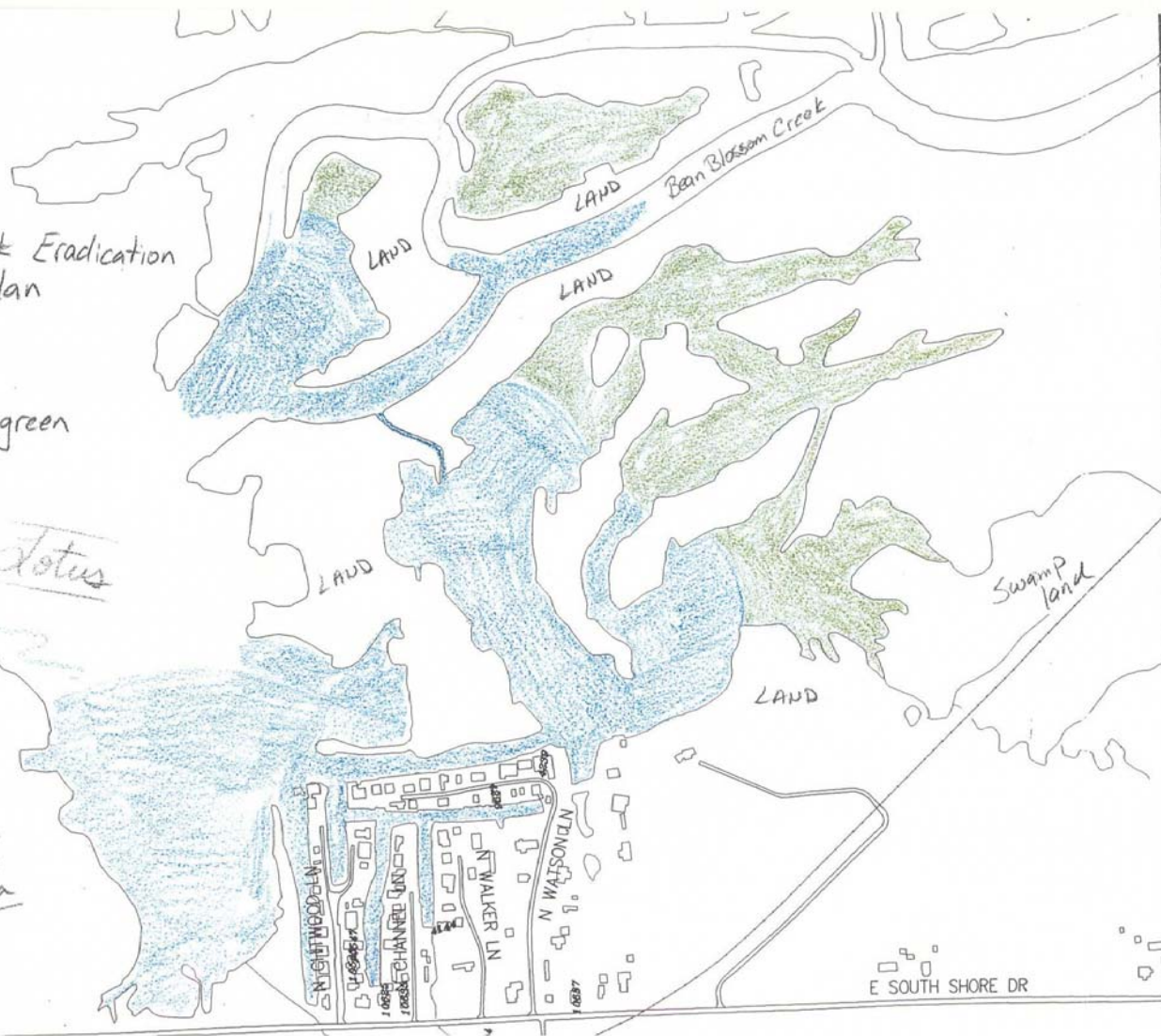
Key
Spatterdock - green
Water - blue
Land white

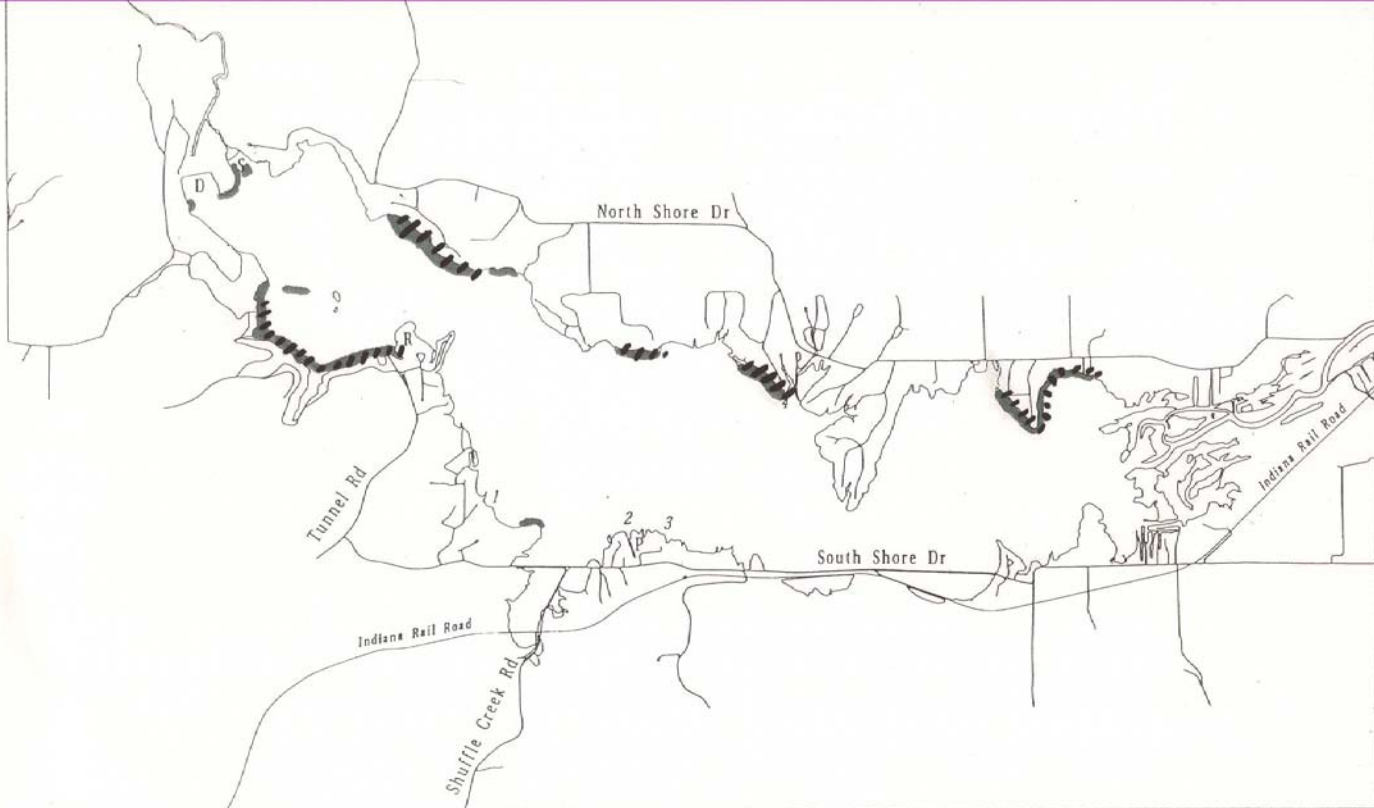
Lotus

Lotus

Little Africa

UTH SHORE DR





Milfoil Present



Areas Sprayed (Aquathol K)

Scale: 1" = 3000'

Figure B: Early Eurasian Water Milfoil (April – May)



21 Mar 2001

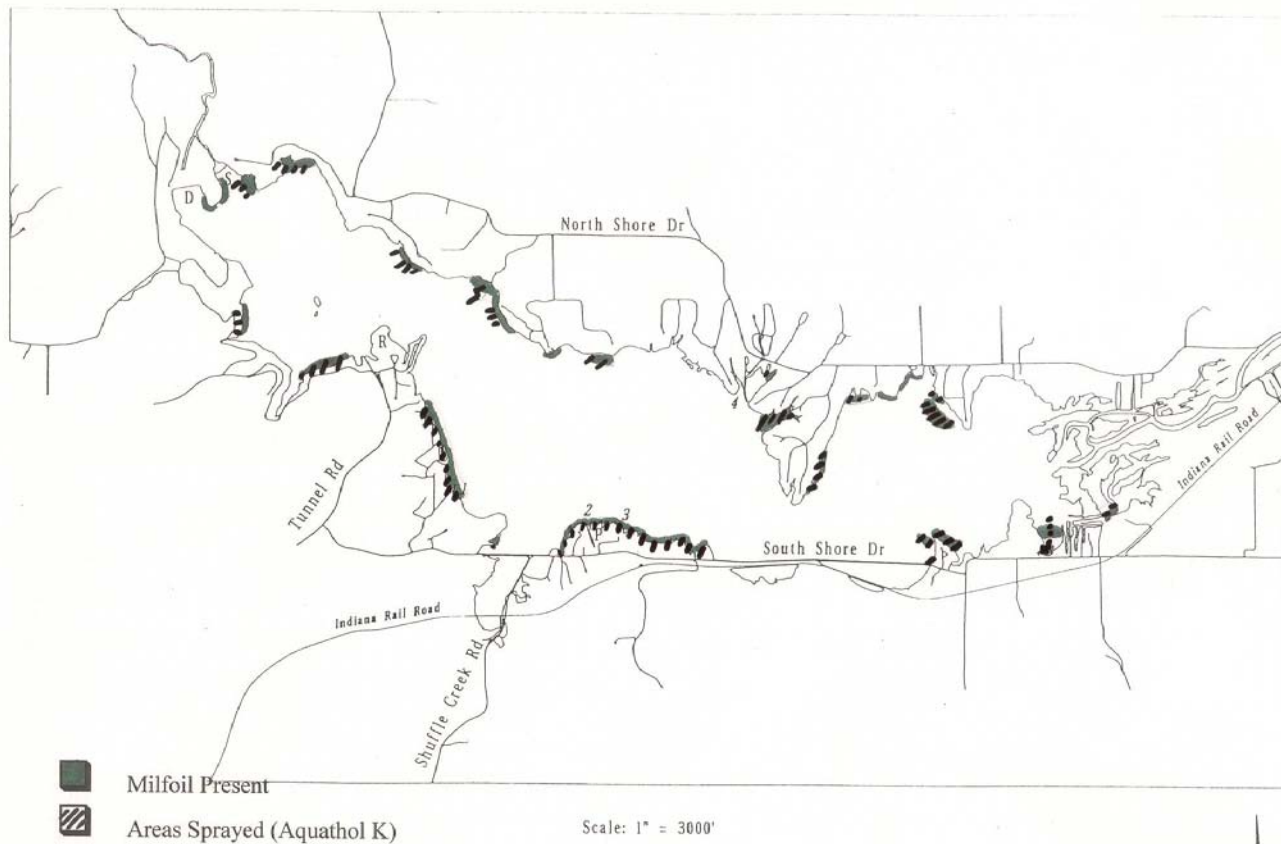
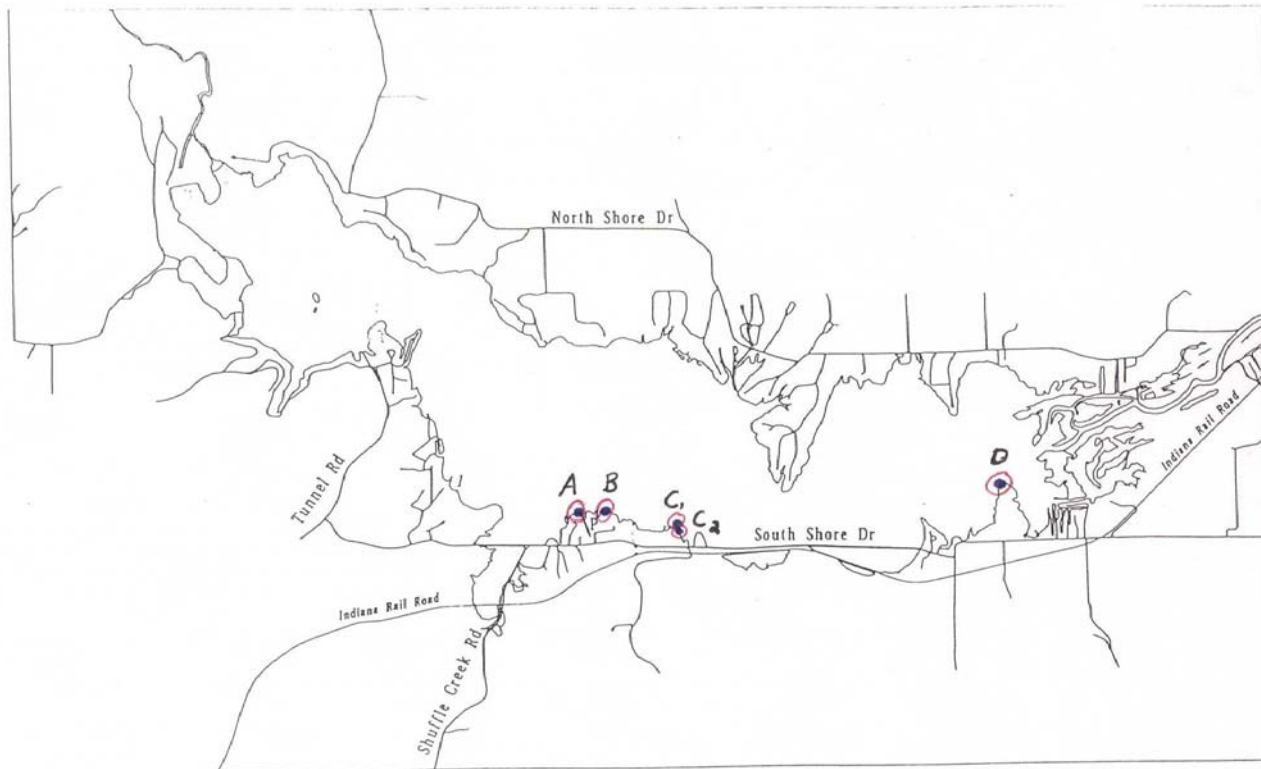


Figure C: Late Eurasian Water Milfoil (June – August)



● Areas with Purple Loosestrife

Scale: 1" = 3000'

A Ornamental Planting

B Location of approximately 40 plants

C Location of approximately 15 plants

D Location of approximately 2 plants

Figure D: Purple Loosestrife



21 Mar 2001



Lake Lemon Conservancy District

April 2, 2003

Please find enclosed the 2002 addendum to the Lake Lemon Conservancy District Aquatic Plant Management Plan. This addendum highlights the areas sprayed during the 2002 season and the establishment of a second maintenance line on the north side of the lake, west of Point Idalawn.

For the 2003 season, LLCD will be reviewing aquatic vegetation control plans and assessing systemic herbicides for potential in-lake use.

If you have any questions regarding this addendum or the upcoming vegetative control season, please do not hesitate to contact the LLCD office.

Best regards,



Angie Smith
LLCD Biologist

LAKE LEMON CONSERVANCY DISTRICT
AQUATIC PLANT MANAGEMENT PLAN APPENDIX 2

2002 VEGETATION GROWTH AND TREATMENT INFORMATION
NUISANCE/EXOTIC MANAGED SPECIES

American Lotus (*Nelumbo lutea*)

The east end of Lake Lemon supports a substantial crop of American lotus. Seven years of chemical treatment has been successful in reducing the vegetation's distribution in the east end of the lake, but continued treatment is necessary to prevent further encroachment. The current goals for chemical treatment of lotus are the maintenance lines shown in Figure 1 (map provided by Scott Shuler, Aquatic Control). Lotus growing into the lake past these maintenance lines will be treated while vegetation behind these lines will be left for fish and wildlife habitat. Future management of lotus is expected due to the existing seed bank.

Thirty acres of lotus were chemically treated using a combination of AquaPro (chemical content similar to Rodeo), Cide-kick II and Polyon Spray on July 25th (see Figure 1). A follow-up treatment of lotus occurred on September 16th to complete the vegetation treatment season. A small patch of Lotus (<1 acre) east of Riddle Point Park was not treated as it provides cover for fish, but this area will be monitored to prevent future spreading. Conservancy District staff did not mechanically harvest any areas to control the presence of American lotus.

Spatterdock (*Nuphar lutea*)

The distribution of spatterdock continued to expand during the 2002 growing season. Spatterdock growth is concentrated along the banks of Beanblossom Creek, the stream channels on the northeast side of the Conservancy District, the channels of Chitwood Addition, and the bay northeast of Chitwood (see East-end Spatterdock Plan – 2001 Addendum). For the past several years, residents have voiced complaint over lost access and reduced fishing opportunities in these areas. LLCD received a permit from IDNR to treat increased areas of spatterdock in 2002, however this permit only allowed for increasing boating access lanes and opening other areas pertinent to recreational use of Lake Lemon. Approximately two acres of spatterdock were treated, using the same chemical compounds used on American lotus, on July 25th (see Figure 2).

Combining the goals of anglers and residents, LLCD hopes to reopen access areas and prevent further spread of spatterdock while maintaining some areas for fish and wildlife habitat. To proactively manage this species, LLCD will continue to seek permits from IDNR to chemically treat larger areas of spatterdock.

Eurasian Water Milfoil (*Myriophyllum spicatum*)

Due to the excessive milfoil growth observed in previous years, LLCD requested a permit to chemically treat 75 acres of milfoil. The heavy spring rains reduced water clarity, thus postponing the onset of milfoil to late spring/early summer. As the summer progressed, the transparency increased and the growth of milfoil increased (Figure 3).

A total of 76 acres of milfoil were treated using liquid Aquathol-K, and one acre of milfoil was treated using granular Aquathol Super K in 2002. Twenty acres of milfoil were treated on June 24th; one acre on July 25th; forty-five acres were treated on August 14th; and an additional eleven acres were treated on September 16th (see Figure 4). Eight total acres were retreated during the season due to a less than ninety percent kill rate. The Conservancy District staff did not mechanically harvest any areas to control the presence of milfoil.

Purple Loosestrife (*Lythrum salicaria*)

Approximately sixty purple loosestrife plants were observed in three areas on Lake Lemon this season (see Figure 5). Thirty plants were observed on Little Africa, which is the location of the first recorded purple loosestrife plants on Lake Lemon. An additional five plants were found on a small point west of the long causeway by I & S Marine. These plants were removed on July 23rd by first cutting the flowers and seed heads, taking care to avoid dispersing or transporting the seeds, and digging up the roots to prevent future growth. Information provided by a freeholder advised LLCD of approximately twenty-five more plants in the middle of the long causeway. These plants were sprayed with a glyphosate-based chemical on September 12th. Close observation of these and other areas will continue in the spring and summer of 2003.

LAKE LEMON CONSERVANCY DISTRICT

2002 VEGETATION CONTROL PROGRAM SUMMARY

June 24, 2002

- Treated 20 acres of EWM

July 25, 2002

- Treated 30 acres of Lotus
- Treated 2 acres of Spatterdock
- Treated 1 acre of EWM with Aquathol Super K (granular)

August 14, 2002

- Treated 45 acres of EWM
- Retreated 5 acres of EWM

September 16, 2002

- Treated 11 acres of EWM
- Retreated 3 acres of EWM
- Spot follow-up treatment for Lotus and Spatterdock

**Lake Lemon Conservancy District
2002 Aquatic Vegetation Control – Expenses**

CHEMICALS

Date	Unit (gallons)	Chemical	Price per Gallon	Total
12/30/01	100	Aquathol K	\$58.16	\$5,816.00
7/25/02	12	Aquathol Super K (granular)	\$17.84	\$214.08
7/25/02	15.5	AquaPro	\$55.35	\$857.93
7/25/02	8.75	Cide-kick II	\$15.25	\$133.44
7/25/02	9.75	Polyan Spray	\$22.25	\$216.94
8/14/02	225	Aquathol K	\$60.50	\$13,612.50
9/16/02	60	Aquathol K	\$60.50	\$3,630.00

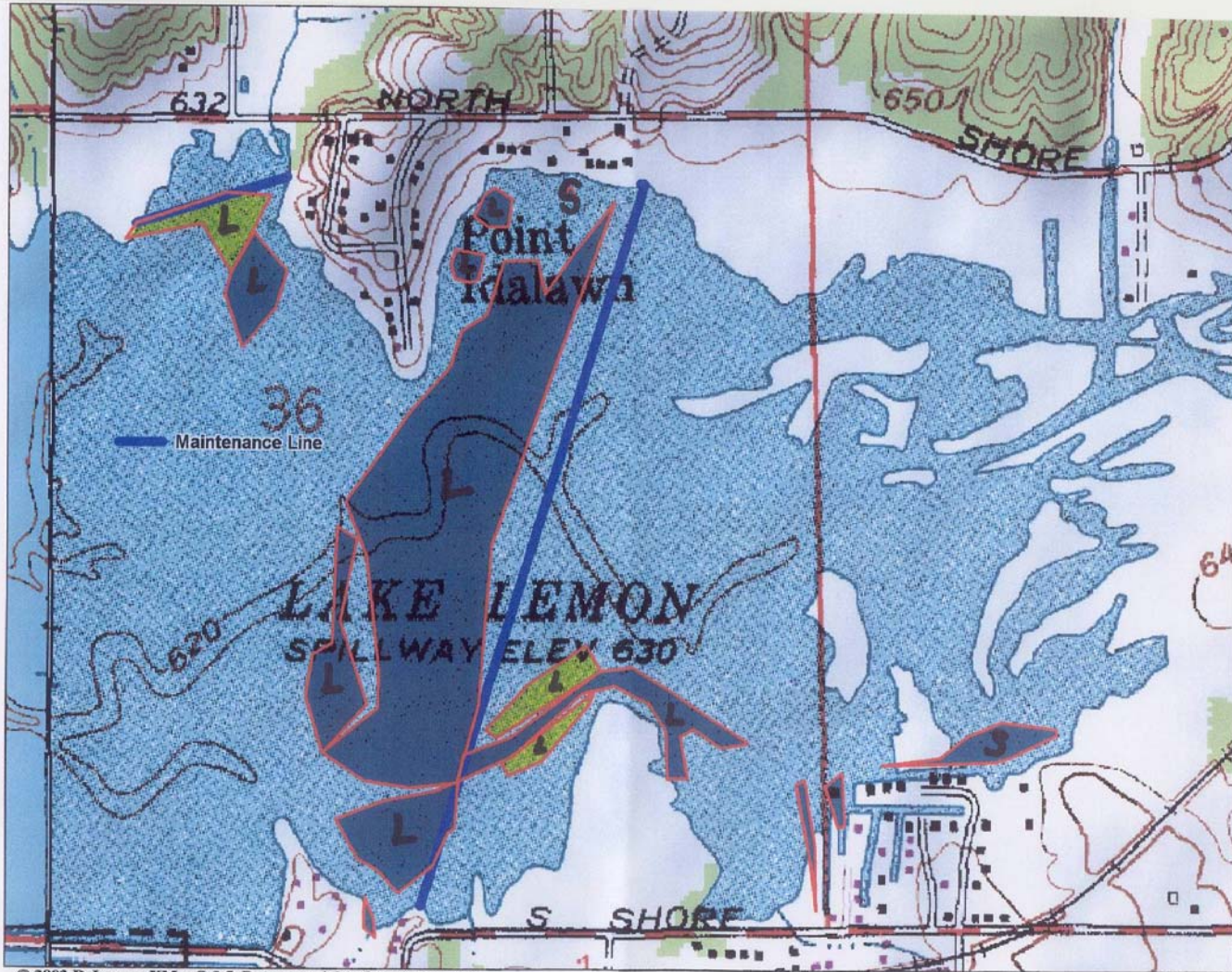
TOTAL CHEMICALS: \$24,480.89

APPLICATION FEES

Acres	Species	Price per Acre	Total
31	Milfoil	\$65.00	\$2,015.00
45	Milfoil	\$50.00	\$2,250.00
30	Lotus	\$250.00	\$7,500.00
2	Spatterdock	\$250.00	\$500.00
1	Milfoil	\$80.00	No Charge

TOTAL APPLICATION FEES: \$12,265.00

2002 TOTAL EXPENSES = \$36,745.89

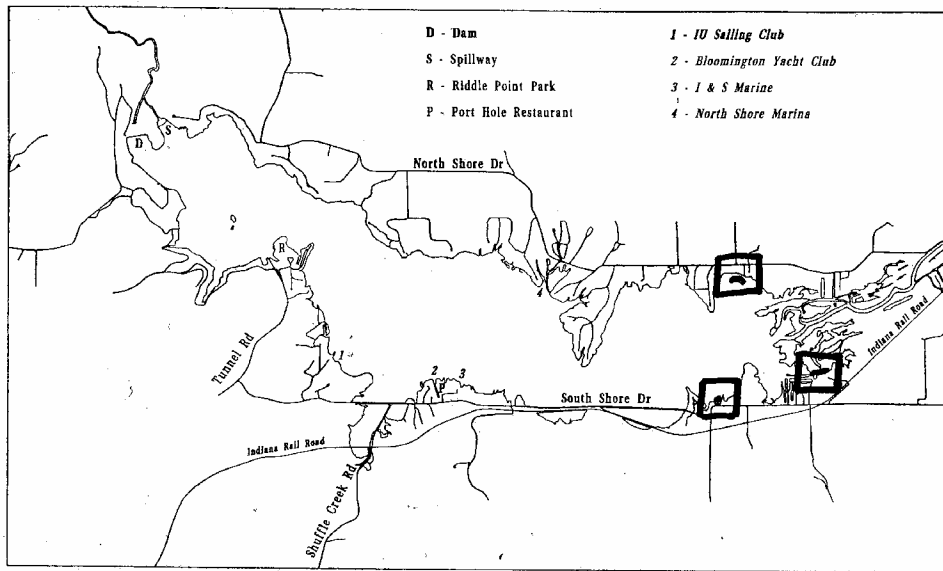


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Scale: 1 : 8,000 Zoom Level: 14-0 Datum: WGS84 Map Rotation: 0° Magnetic Declination: 3.2°W

Figure 1: Lotus (L) and Spatterdock (S) Treated

Lake Lemon



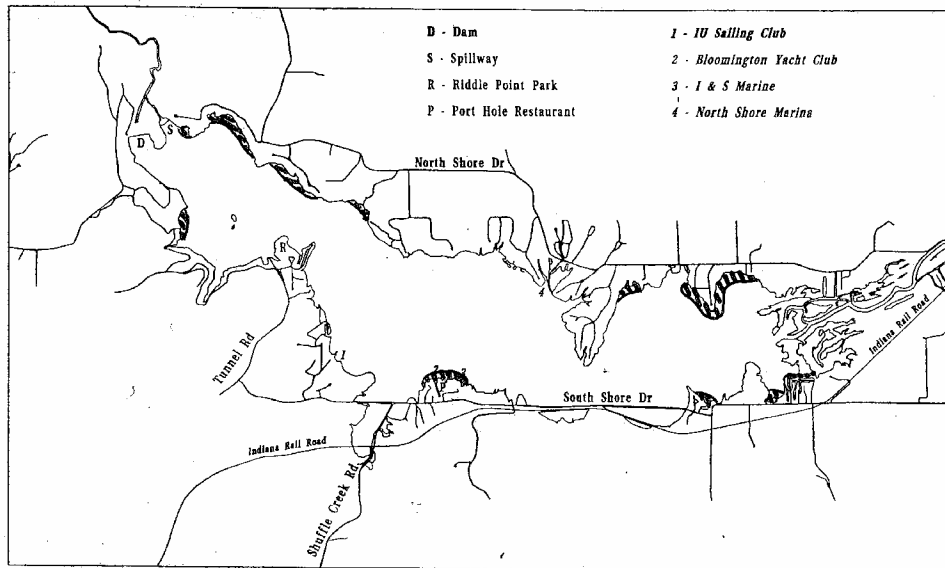
Scale: 1" = 3000'

Lake Lemon Conservancy District

Figure 2: Spatterdock Treatment Areas

21 Mar 2001

Lake Lemon



Scale: 1" = 3000'

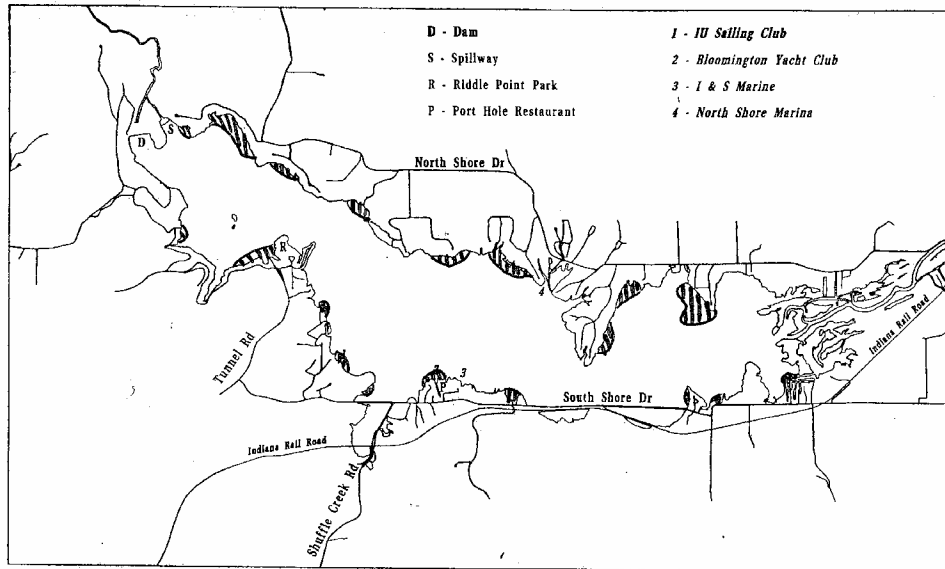
Lake Lemon Conservancy District

Figure 3a: Early Summer Eurasian Watermilfoil



21 Mar 2001

Lake Lemon



Scale: 1" = 3000'

Lake Lemon Conservancy District

Figure 3b: Late Summer Eurasian Watermilfoil



21 Mar 2001



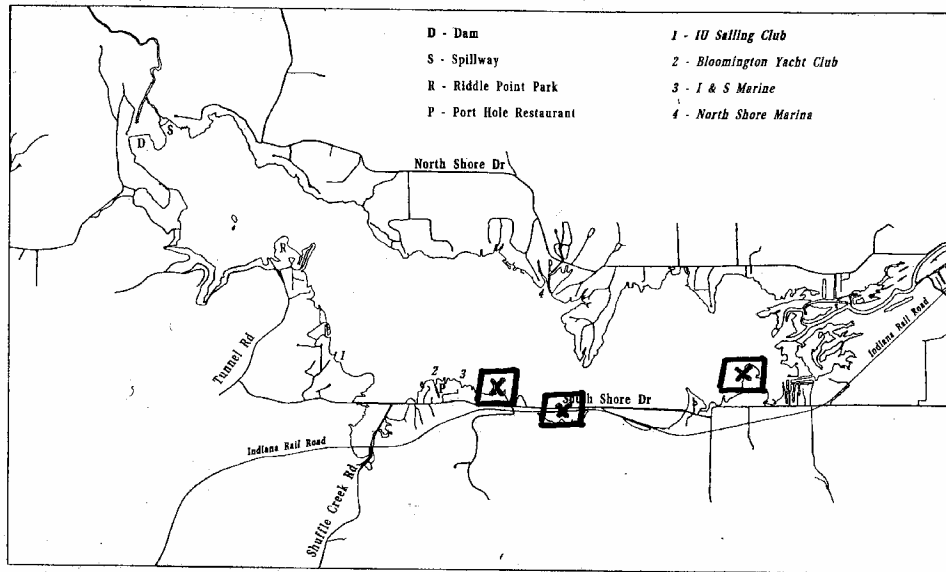
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2,000 ft

Figure 4: Eurasian Watermilfoil Treated

LAKE LEMON



Scale: 1" = 3000'

Lake Lemon Conservancy District
Figure 5: Purple Loosestrife Removed



21 Mar 2001



Lake Lemon Conservancy District

February 19, 2004

Please find enclosed the 2003 addendum to the Lake Lemon Conservancy District Aquatic Plant Management Plan. This addendum highlights the areas sprayed during the 2003 season.

If you have any questions regarding this addendum or the upcoming vegetative control season, please do not hesitate to contact the LLCD office.

Best regards,

A handwritten signature in cursive script that reads "Coleman Smith". The signature is written in black ink and is positioned above the printed name.

Coleman Smith
LLCD Biologist

LAKE LEMON CONSERVANCY DISTRICT
AQUATIC PLANT MANAGEMENT PLAN APPENDIX 3

2003 VEGETATION GROWTH AND TREATMENT SUMMARY

Currently Managed Species

American Lotus (*Nelumbo lutea*)

The east end of Lake Lemon supports a substantial crop of American lotus. Eight years of chemical treatment has been successful in reducing the vegetation's distribution in the east end of the lake, but continued treatment is necessary to prevent further encroachment. The current goals for chemical treatment of lotus are the maintenance lines shown in [Figure 1](#) (maps provided by Scott Shuler, Aquatic Control). Lotus growing into the lake past these maintenance lines will be treated while vegetation behind these lines will be left for fish and wildlife habitat. Future management of lotus is expected due to the existing seed bank.

Twelve acres of lotus were chemically treated using a combination of AquaPro (chemical content similar to Rodeo), Cide-kick II and Polyan Spray on July 10th (see [Figure 1](#)). A follow-up treatment of three acres of lotus occurred on September 28th to complete the vegetation treatment season. A small patch of lotus (<1 acre) east of Riddle Point Park was not treated as it provides cover for fish, but this area will be monitored to prevent future spreading. Conservancy District staff did not mechanically harvest any areas to control the presence of American lotus.

Spatterdock (*Nuphar lutea*)

Spatterdock growth is concentrated along the banks of Beanblossom Creek, the stream channels on the northeast side of the Conservancy District, the channels of Chitwood Addition, and the bay northeast of Chitwood (see East-end Spatterdock Plan – 2001 Addendum). For the past several years, residents have voiced complaint over lost access and reduced fishing opportunities in these areas. LLCD received a permit from IDNR to treat increased areas of spatterdock in 2003, however this permit only allowed for boating access lanes and opening other areas pertinent to recreational use of Lake Lemon. Approximately three acres of spatterdock were treated, using the same chemical compounds used on American lotus, on July 10th (see [Figure 2](#)).

Combining the goals of anglers and residents, LLCD hopes to reopen access areas and prevent further spread of spatterdock while maintaining some areas for fish and wildlife habitat. To proactively manage this species, LLCD will continue to seek permits from IDNR to chemically treat larger areas of spatterdock.

Eurasian Water Milfoil (*Myriophyllum spicatum*)

Under the advisement of Aquatic Control, Inc. the LLCD used a new chemical, Renovate 3, to control the abundance of Eurasian water milfoil at Lake Lemon. Renovate 3 proved very successful at killing the treated milfoil plants after first contact with the chemical.

Due to the excessive milfoil growth observed in previous years, LLCD requested a permit to chemically treat 75 acres of milfoil. On May 30th, a total of thirty-four acres of milfoil were treated using Renovate 3. Forty-one acres of milfoil were treated on July 10th; and one and a half acres on August 28th also using the chemical Renovate 3 (see [Figures 3-zones & 3b](#)). The Conservancy District staff did not mechanically harvest any areas to control the presence of milfoil.

Purple Loosestrife (*Lythrum salicaria*)

Approximately twenty-five purple loosestrife plants were observed in two areas on Lake Lemon this season (see [Figure 4](#)). Twenty plants were observed growing on a resident's shoreline located along South Shore Drive. An additional five plants were found on residential shoreline east of Lake Lemon Marina. These plants were removed in June by first cutting the flowers and seed heads, taking care to avoid dispersing or transporting the seeds, and digging up the roots to prevent future growth. Close observation of these and other areas will continue in the spring and summer of 2004.

Common Naiad (*Najas flexilis*)

A small mass of common naiad was reported to the LLCD office by a freeholder in early July. The plants were located between two docks directly west of I&S Marine (see [Figure 5](#)). On July 10th, the LLCD biologist treated the area with one gallon of Weedtrine D provided by Aquatic Control, Inc. After treatment, the area was closely monitored. There was no other growth of common naiad reported on the lake. The treated area will remain under observation during the 2004 growing season.

Additional Nuisance Species

Due to the selective properties of the new systemic chemical, Renovate 3, it is more successful at eliminating the targeted species. But, this also allows new species to grow in the areas left vacant by the chemically controlled plants. Therefore, the LLCD staff has found the need to identify plants that have historically not been a nuisance in Lake Lemon, but are now encroaching boating lanes and docking areas due to the chemical removal of other plants mentioned above. All of the species described subsequently have increasing populations located at the east end of the lake.

Brittle Naiad (*Najas minor*)

On August 28th, the exotic species commonly known as brittle naiad was identified encroaching the boating lanes north and east of the Little Africa wildlife nature preserve. Brittle naiad is a submerged, annual aquatic herb that has many branches of smooth leaves. The plant can be found in the quiet waters found on the east end of Lake Lemon.

Coontail (*Ceratophyllum demersum*)

Coontail is a native species to Lake Lemon that was identified by the original plant management plan published by the LLCDC in 2000. Coontail is a beneficial plant that provides good habitat for young fish and ducklings. During the summer of 2003, coontail began to encroach many of the boating lanes located in Chitwood Addition on the east end of the lake. The encroachment has been attributed to the successful seasonal elimination of Eurasian water milfoil. The LLCDC hopes to be permitted to control for critical encroachment areas of coontail during the summer of 2004.

American Pondweed (*Potamogeton nodosus*) & Small Pondweed (*Potamogeton pusillus*)

American pondweed and small pondweed are native to the United States. They can be found in any freshwater body of water. Pondweeds usually grow in stands of mixed species. Problems associated with these pondweed species include dense stands that can restrict swimming, bank fishing, and boating activities. Both American pondweed and small pondweed are encroaching the boating lanes near Little Africa wildlife nature preserve.

Native Elodea (*Elodea nuttallii*)

Native elodea is a submerged perennial herb found in the quiet waters of lakes and streams. Native elodea has been identified at the east end of the lake near the Little Africa wildlife nature preserve. As with the other newly identified species, native elodea has been observed encroaching the boating channels in the east end of Lake Lemon during the 2003 summer.

**Lake Lemon Conservancy District
2003 Aquatic Vegetation Control – Expenses**

CHEMICALS

Unit (gallons)	Chemical	Price per Gallon	Total
287.5	Renovate 3	\$ 92.00	\$ 26,450.00
1	Weedtrine D	\$ 55.90	\$ 55.90
5	Renovate 3	\$ 92.00	\$ 460.00
8	Aqua Pro	\$ 55.35	\$ 442.80
4	Polyan Spray	\$ 23.00	\$92.00
5	Cide Kick II	\$ 15.25	\$ 76.25

TOTAL CHEMICALS: \$ 27,576.95

APPLICATION FEES

Acres	Species	Price per Acre	Total
76.5	Milfoil	\$52.00	\$ 3,978.00
15	Lotus	\$250.00	\$ 3,750.00
3	Spatterdock		No charge
0.5	Common Naiad	Self-applied	No charge

TOTAL APPLICATION FEES: \$ 7,728.00

2003 TOTAL EXPENSES = \$ 35,304.95

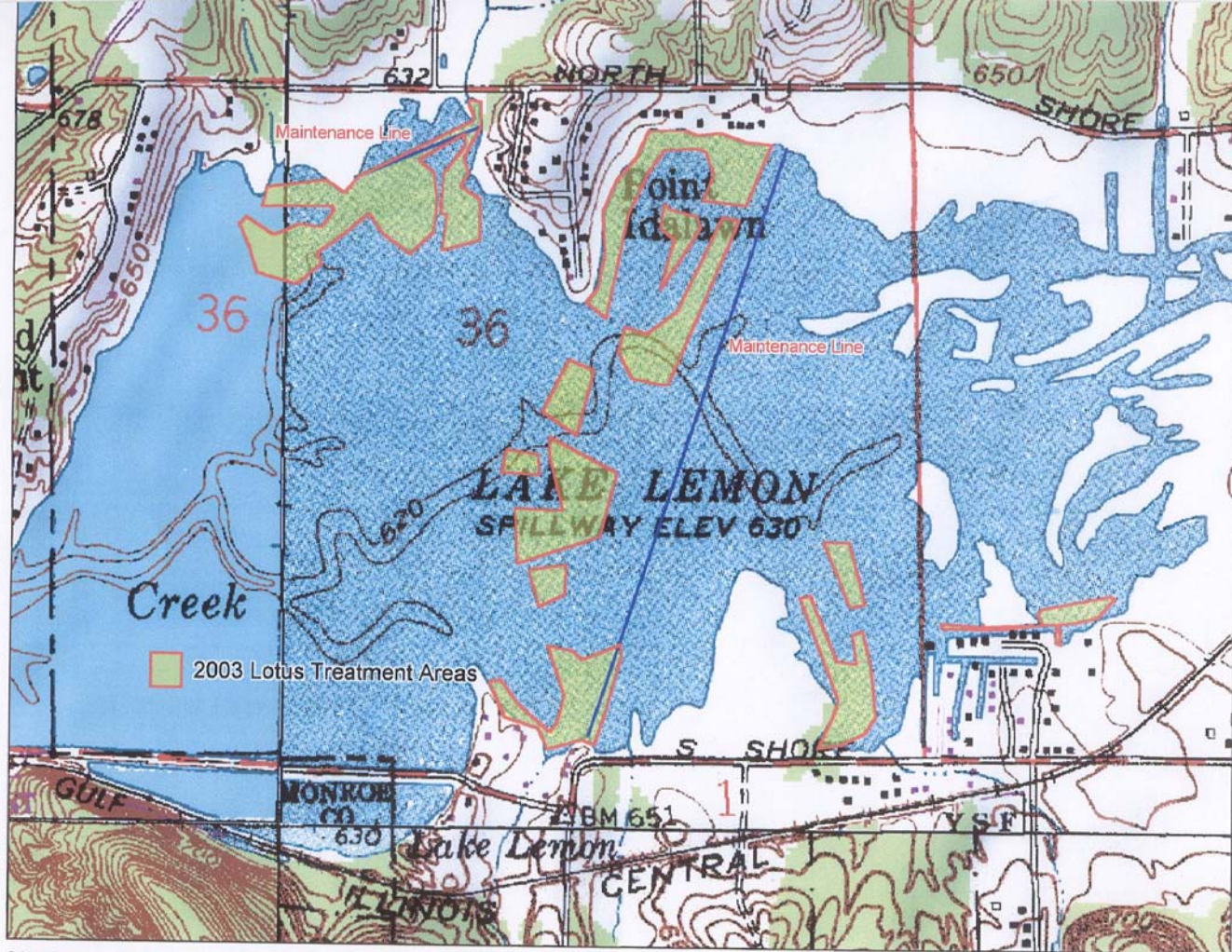
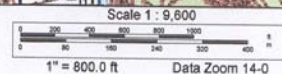
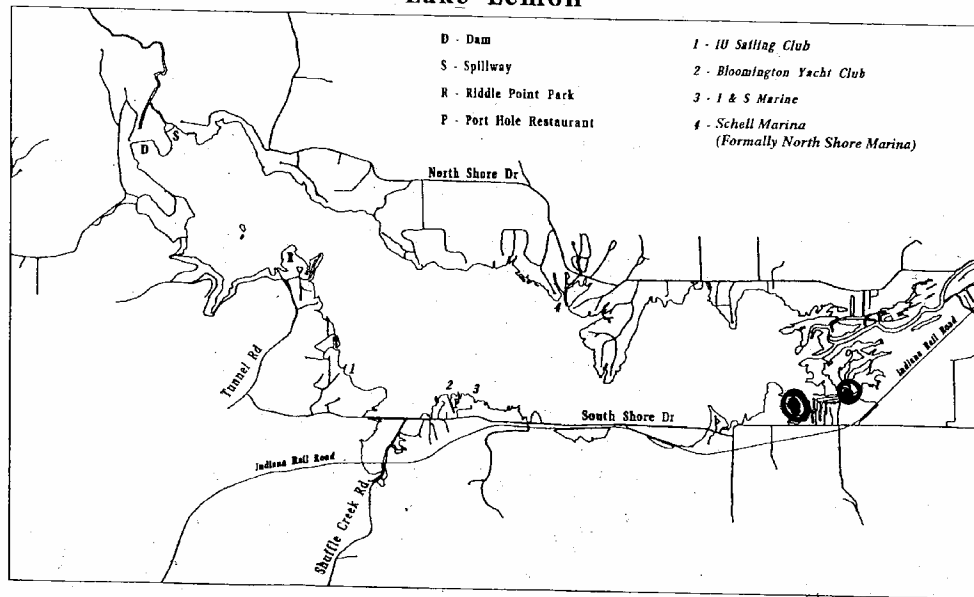


Figure 1: Lotus Treatment Areas



Lake Lemon



Scale: 1" = 3000'

Lake Lemon Conservancy District

Figure 2: Spatterdock Treatment Areas

PlanCorGIS

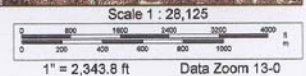
21 Mar 2001



Figure 3a: Early Summer Milfoil Treatment



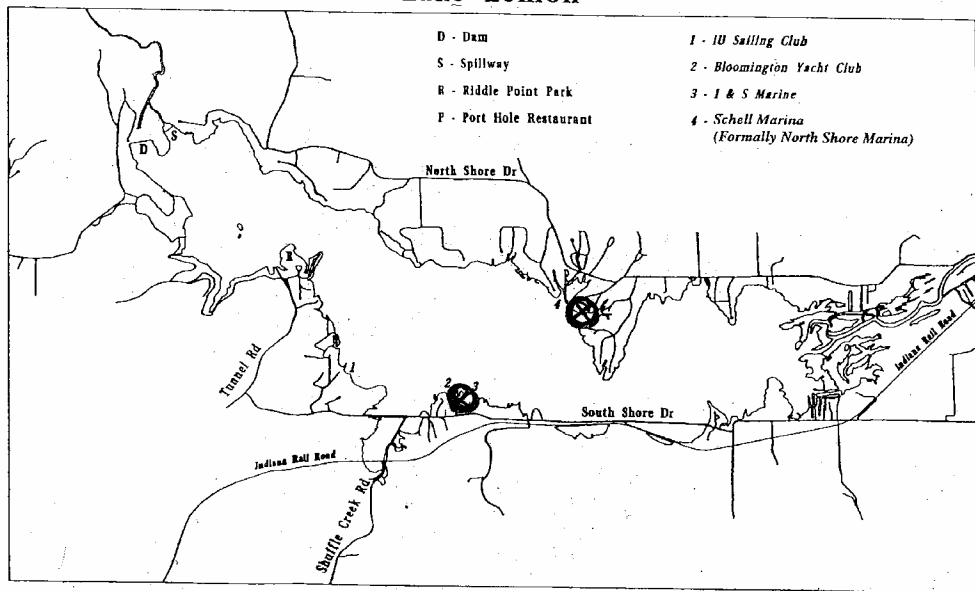
Figure 3b: Late Summer Milfoil Treatment



LAKE LEMON


- D - Dam
- S - Spillway
- R - Riddle Point Park
- F - Port Hole Restaurant

- 1 - IU Sailing Club
- 2 - Bloomington Yacht Club
- 3 - I & S Marine
- 4 - Schell Marina
(Formerly North Shore Marina)

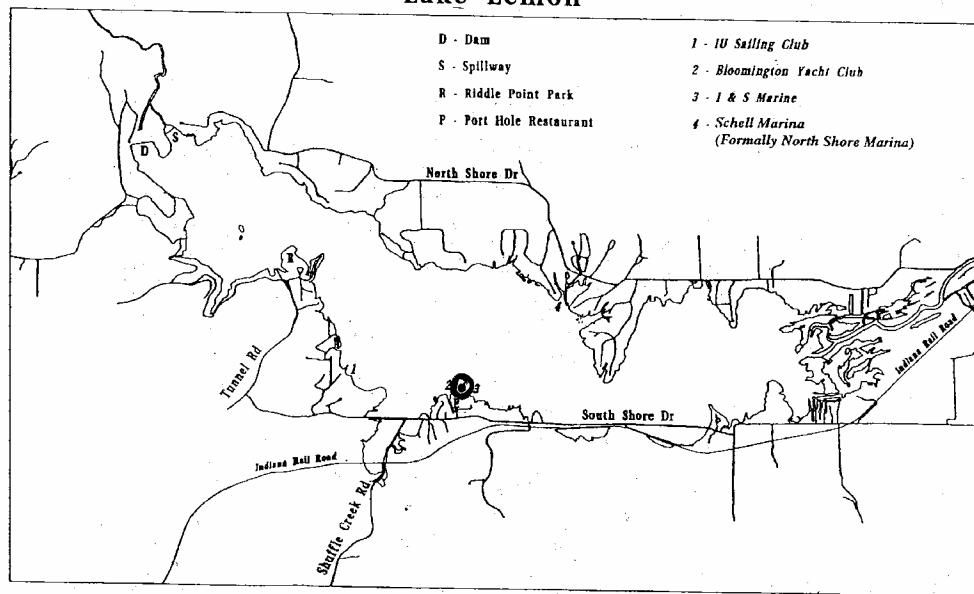


Scale: 1" = 3000'

Lake Lemon Conservancy District

Figure 4: Purple Loosestrife Removed 

LAKE LEMON



Scale: 1" = 3000'

Lake Lemon Conservancy District

Figure 5: Common Naiad Treatment 